THE
U[illegible]E
Of the GEOMETRICAL
Playing-Cards,
As also a Discourse of the
Mechanick Powers.

By Monsi. *Des-Cartes*.

Translated from his own Manuscript Copy.

SHEWING
What Great Things may be performed by MECHANICK ENGINES in removing and raising Bodies of vast Weights with little Strength or Force.

LONDON,
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The Definition of a POINT.

THE Point, is that which hath not any Part.

By this Definition, it is easie to conceive, that the Point hath neither length, nor breadth, nor depth, and that also it is not sensible, but only Intellectual; seeing that there is nothing which falleth under sense, which hath not a quantity, and that there is no quantity without Parts, which would altogether contradict this Definition. Neverthelesss, as none can make any Operation, but by the Interposition of Corporal things, they represent therefore the Mathematical Point, by the Point Physical, which is the Object of the sight, the smallest and least sensible, which hath no Geometrical greatness, divisible to our sense, and is made with the Point of a Needle, or with the end of the Point of the Compass of a Pen, or Pensil, as the Point noted by *A*.

The Point Central, or Center, is a Point by which a Circle is drawn, or a Circumference, or rather it is the midst of a Figure, as *C*.

The Point Secant, is a Point where the Lines do interdivide themselves, and which is ordinarily called a Section, as *C D*.

See the Ace *of* Diamonds.

The Definition of a LINE.

THe *Line*, is a Length without Breadth: The *Line* is no other thing, then the passing of the Point from one place to another, and it would be unperceivable, if one should not set it forth by a Point Physical, the which by its flowing, doth represent to us, as *A B*, *C D*, *E F*.

There are many sorts of *Lines*, as the Point, which is the Original thereof, is able to receive different Motions; nevertheless, they take into consideration only two Single and Principal ones; the Straight, and the Crooked; and a third also, which they call the Mixt, because that it is composed of the two first.

The right, or straight *Line* is, that which is equally comprized within its extremities.

Otherwise, it is that which floweth from one Point to another, without any turnings aside, as *A B*.

The Crooked *Line*, is that which turneth, or wandreth from its Extremities, by one, or more Turnings aside, as *C D*.

When as this *Line* is described with a Compass, they call it Circular, as *E*.

The Mixt *Line*, is that which is Straight and Crooked, as the *Line* V.

See the Ace *of* Diamonds.

The

The LINE is diſtinguiſhed into Finite and Infinite, into Apparent and Occult, or Hidden.

THe *Line* Finite, is a *Line* Bounded, which containeth, or ſuppoſeth, a length neceſſary, as *A*.

The Infinite, is a *Line* undetermined, which hath no preciſe length, as *B*.

The Apparent, or Traced out, is that which is deſcribed with Ink or Pencil, as *A B*.

The Occult, or White, which is drawn only with the Point of the Compaſs, or marked with Points, and therefore they call it, the Pointed, or Line with Points, *as C*.

Here endeth the Ace *of* Diamonds.

The Line *receiveth alſo divers Denominations, according to its divers Poſitions and Proprieties.*

A Perpendicular, is a right *Line*, which falleth, or lifteth it ſelf up upon another maketh the Angles of the one part, and, the other, equal between themſelves, as *A B*.

A Plumb *Line*, is that which goeth from high to low without bending, either to the right, or to the left, and which would paſs through the Center of the World, if it were prolonged infinitely, as *C*.

See the Duce *of* Diamonds.

A *Line* Horizontal, is a *Line* in an equal poize, which inclineth it ſelf equally on the one part, and the other, as *D E*.

Lines Parallels, are thoſe which follow each other by an equal diſtance, as *H*.

An Oblique *Line*, which is neither Horizontal, nor a Plumb-line, but of a Bias, as *F G*.

The Baſis is the Line, upon which the Figure repoſeth it ſelf, as *I L*.

Sides, are thoſe Lines which encompaſs a Figure, as *I N. N M*.

THe Diagonal, is a right *Line* that traverſeth a Figure, and that which endeth at two Angles oppoſite, as *A B*. The Diameter, is a right *Line*, which traverſeth, or paſſeth through a Circular Figure by its Center, and which ends at the Circumference.

A Spiral *Line*, is a Crooked *Line*, which parteth from its Center, and groweth farther off in proportion as it turneth about, as *E E*.

The Cord, or Subtendant is a right Line, which is join'd to an Arch, or Bow by its ends, as *G H*.

The Arch, or Bow, is a Part of a Circumference, as *G I H*. A Line Tangent, is that which toucheth any Figure, without dividing it, and without being able to divide, or paſs through it, although it were prolonged, as *L M*.

See the Duce *of* Diamonds.

A

A *Line* Secant, which Crosseth, which divideth, or traverseth, as *L O. M O.*

The Definition of the ANGLE.

AN *Angle*, is the indirect meeting of two Lines, at one and the same Point, or rather it is the space encompassed between the indirect meeting, or concourse of two lines, joining together in one Point, as *A B C.* When as this Concourse is made of two right Lines, the *Angle* is called *Rectilinear*, and when it is made of two crooked Lines, it is called *Curvi-linear* ; but when it is made of one right Line, and one crooked Line, it is called *Mixtilinear.*

A. The Angle *Rectilinear.*
B. The Angle *Curti-linear.*
C. The Angle *Mixt-linear*, or *Composite.*

The Angle *Rectilinear*, according as it is more or less open, it receiveth particular Denominations ; as Right, Sharp, Obtuse, or Blunt : So that these Terms of Rectilinear, Curvi-linear, and Mixt, are in respect of the Quality of the Lines, and these of Right, Sharp and Obtuse, are in respect of the quantity of the space inclosed within the said Lines.

It is a right Angle, when one of the Lines is Perpendicular upon the other, as *E D F.*

See the Tray *of* Diamonds.

The Angle is ſharp, when as it is leſs open than the right Angle, as *E D G.*

The Angle is Obtuſe, when it is more open than the Right Angle, as *F D G.*

The Letter *D* in the midſt ſheweth the Angle.

Here endeth the Tray *of* Diamonds.

The Definition of the Superficies.

THe *Superficies* is that which hath length, and breadth without depth.

According to the Geometricians, the Superficies is a Production of the flowing forth of the Line, as the Line is a Production of the Point: And thus we muſt conceive, that the Line *E F.* flowing towards *G H.* doth make the Superficies *E F G H.* which is an extenſion bounded with Lines, which hath nothing but length and breadth without any depth or thickneſs, which is called the Surface, or Figure, if one conſider it in reſpect of its extremities, which are the Lines that encloſe it.

If the Superficies be on the upper part, it is called a Convex, if it be in the inner, or hollow part, it is called a Concave, if it be plane and united, it is called a Plane.

B. A Convex Superficies.

C. A Concave Superficies.

A. A Plane Superficies.

See the Four *of* Diamonds.

The

The first Part teacheth only the Construction, a framing of plain Superficies.

A Term, or Bound, is the extremity of any thing. The Point, is the Term, or Bound of the Line. The Line, is the Term of the Superficies. And the Superficies, is the Term, or Bound, of a Body. *Here endeth the* Four *of* Diamonds.

Of Superficies, *or* Figures *Rectilinear.*

THe *Superficies* do take particular Names, according to the Number of their Sides, as

A. A Trigone, or Triangle, a Figure of 3 sides.
B. A Tetragone, or Square, a Figure of 4 sides:
C. A Pentagone, or Figure of 5 sides.
D. An Exagone, or Figure of 6 sides.
E. Eptagone, a Figure of 7 sides.
F. Octogone, a Figure of 8 sides.
G. Enneagone, a Figure of 9 sides.
H. Decagone, a Figure of 10 sides:
I. Endecagone, a Figure of 11 sides.
L. Dodecagone, a figure of 12 sides.

All these Figures are called likewise by one general Name Poligones.

Of TRIANGLES.

The Triangles are also distinguished by the quality of their Angles, and by the disposition of their sides, as

M. A Triangle Rectangle, which hath a Right Angle.

See the Five *of* Diamouds.

N. A Triangle Ambligone, which hath an Obtuse Angle.

O. A Triangle Oxigone, which hath Three Angles sharp.

P. A Triangle Equilateral, which hath its Three sides equal.

Q. A Triangle Iso fele, which hath two sides equal only.

R. A Triangle Scalene, which hath his three sides une jual.

Here endeth the Five *of* Diamonds.

Of Figures *of Four Sides.*

A. THe *Square*, is a Figure composed of four equal Sides, and four right Angles.

B. A Long Square, is a Superficies Rectangle, that is to say, which hath its Angles right, but hath not its Sides equal.

A B C. A Parallelo-gramme, is a Square-side figure, whereof the opposite sides are Parallels.

D. A Rhombus, or Lozange, is a square side figure, which hath the four sides equal, but not the four Angles.

E. A Rhomboid, which hath the Angles and the side opposite equal, without being equal-angled, or equal-sided.

F. A Trapeze, which hath only two sides opposite Parallel, and the other two equal.

See the Six *of* Diamonds.

G. A

G. A Trapezoide, or Tablett, which hath its Sides and its Angles unequal.

H. A Gnomon, is the excefs of a Parallelo-gram upon another Parallo-gram, framed upon the fame Diagonal.

All other Figures, of more than four Sides, are called by one general Name, Multi-lateres, *or,* Many-Sizes.

Here endeth the Six *of* Diamonds.

Of Figures *Crooked, or Curvi-linear.*

A. A Circle, is a Superficies, or Figure, perfectly round, defcribed, or drawn from a Center, from which the whole Circumference is of equal diftance.

A B C D. The Circumference is the Extremity, or outmoft part of the Circle, otherwife it is the Circular-line that enclofeth it.

B. An Oval, is a crooked Figure drawn from many Centers, and which all the Diameters divide into two equally.

C. An Eclipfe, is alfo a crooked Figure drawn from many Centers, but in fhape of an Egg, within the which there is but one only Diameter, which divideth it into two equally.

D. A Volute, is a Figure, or Superficies, encompaffed by a Line Spiral.

See the Seven *of* Diamonds.

Of

Of FIGURES *Composite.*

A. A Demi-Circle, is a Figure contained in the Diameter, with the half of the Circumference.

B. A part of a Circle, is a Figure contained within a right Line, and a part of a Circle.

F. The great Portion of the Circle, is that which containeth more than the half of the Circle.

G. The ſmall Portion of a Circle, is that which containeth leſs than the half of the Circle.

C. A Sector, is a Figure contained within two Semi-Diameters, with more, or leſs, than the half of the Circle.

There is likewiſe the great and the ſmall Sector.

D. Figures Concentrical, are thoſe which have one and the ſame Center.

E. Figures Excentrical, are thoſe which are contained in others of divers Centers.

Here endeth the Seven *of* Diamonds.

Of Figures Regular *and* Irregular.

A. A Figure Regular, it that which hath its oppoſite parts like an Equal.

B. An Irregular Figure, is that which is compoſed of Angles and Sides unlike.

E E. Figures a-like, are thoſe whereof all the Parts of one, are proportionable to all the

See the Eight *of* Diamonds.

Parts

Parts of the other, although the one be greater, or equal, or leſſer than the other.

F F. Figures equal, are thoſe which contain equally, which may be like and unlike.

C. The Figure Equi-Angle, which hath all its Angles equal.

E E. One Figure is Equi-Angle to another, when as all the Angles of the one, are equal to all the Angles of the other.

C D. A Figure Equilateral, which hath all its Sides equal.

Here endeth the Eight *of* Diamonds.

The AXIOMES.

I.

Things equal to the one and the ſame, are equal amongſt themſelves.

By the Definition of a Circle.

The Lines A C, A C. which are equal to A B. are alſo equal between themſelves.

II.

If to equal Things, one ſhall add Things equal, all will become equal.

The Lines A C, A C, are equal.
The added C D, C D, are equal.
All of them A D, A D. are alſo equal.

See the Nine *of* Diamonds.

III.

III.

If from equal Things, one take equal Things, the Remainder ſhall be equal.

If from equal Lines	A D, A D.
One take equal Parts	A C, A C,
The Parts remaining	C D, C D.
Shall be alſo equal.	

IV.

If to Things unequal, one add Things equal, the whole will be unequal.

If two Lines unequal	D E, D E.
One does add the equal	A D, A D.
The whole	A E, A E.
Shall be unequal.	

V.

If from Things unequal, one take Things equal, ehe Remainder ſhall be unequal.

If from the Lines unequal	A E, A E.
One take the equal	A D, A D.
The remainder	D E, D E.
Shall be unequal.	

VI.

The Things that are double to one another, are equal between themſelves.

The right Lines	D D, D D.

See the Nine *of* Diamonds.

Which

Which are double to the line A D.
Are equal between themſelves.

VII.

The Things which are the half of the one and the ſame, or of Things equal, are equal amongſt themſelves.

The Lines A D, A D, which are half of the Lines D D, D D, are equal between themſelves.

That which is ſaid of Lines, may be alſo ſaid of Numbers, Superficies, and of Bodies.

[*Here endeth the* Nine *of* Diamonds.

The Petitions, *or* Demands, *ſerving for the Ordering of the* Practice.

Demand I.

D*Raw a ſtraight Line from the Point* A. *to the Point* B.

The Practice.

Apply the Rule to the Points A and B. Draw the Line demanded A B. by letting the Pencil, or Draught, run cloſe to the rule from the point A. unto the point B.

Demand II.

E*nlarge infinitely the Line* C D. *as the ſide of the end* D.

[*See the* Ten *of* Diamonds.

The

The Practice.

Join the Rule to the Line C D. Continue infinitely the ſaid Line C D. on the ſide of the end D. letting the Pen run by the Ruler towards E.

Demand III.

Draw a Circle from the Point A. *and the Interval* A B.

The Practice.

Set one of the Points of the Compaſs at the Point given A. Open the other unto the point B. Turn the Compaſs upon the Point A. And drawing it from the Point B. Deſcribe the Circle demanded B C D.

Demand IV.

From the Points given E *and* F. *make a Section.*

The Practice.

Open the Compaſs at pleaſure, yet in ſuch manner, that the opening of two Points may be greater than the half of the diſtance, which is between the two Points propounded E and F. By this opening of the Compaſs from the Point E, draw the Arch L M. From the point F. draw the Arch H I. The Section G. ſhall be the demanded.

[*Here endeth the* Ten *of* Diamonds.

PROPO-

PROPOSITION I.

TO *elevate a Perpendicular from a Point propounded within the midſt of a ſtraight Line.*

The Poſition.

Let C be the Point propounded within the midſt of the Line A B, from which a Perpendicular muſt be elevated.

The Practice.

From the Point given C. draw at pleaſure the half-circle D E, from the Points D and E. Make the Section I. from the Point C. Draw the right Line demanded C O. by Section I. This Line C O. ſhall be Perpendicular to the Line given A B. and elevated from the Point propounded C.

PROPOSITION II.

To elevate a Perpendicular at the end of a right Line propounded.

Let A be the end propounded of the Line A B. upon the which a Perpendicular muſt be elevated.

The Practice.

Set at pleaſure the Point C. above the Line A B. From this Point C. and the Interval C A. draw the portion of the Circle E A D. Bring the right Line D C E. by the Points D and C. Draw the Line demanded A E. it ſhall be Per-

[*See the* King *of* Diamonds.

pen-

pendicular to A B. and to the End propounded A:

Otherwise.

From the Point A, draw the Arch G H M.
From the Point G, draw the Arch A H.
From the Point H, draw the Arch A M N.
From the Point M, draw the Arch H N.
Draw the Line demanded A N.

[*Here endeth the* King *of* Diamonds:

PROPOSITION III.

Upon an Angle given, to elevate a right Line, which inclineth neither to the right hand, nor to the left.

The Position.

Let B A C be the Angle, upon the which a right Line must be elevated, which inclineth neither to the right hand, nor left.

The Practice.

From the Angle given A. draw at pleasure the Arch B C. from the Points, or Ends B and C. Make the Section D. from the Point, or Angle given A. Draw the right Line required A D. by the Section D. This right Line A D. shall be elevated upon the Angle B A C. without inclining either to the right hand, or to the left.

[*See the* Queen *of* Diamonds.

PROPOSITION IV.

To depress, or bring down a Perpendicular-Line upon a right Line given, and from a Point without the same.

The Position.

Let C. be the Point given, from which a Perpendicular Line is to be brought down upon the Line A B.

The Practice.

From the Point given C. draw, at pleasure, the Arch D E. cutting the Line A B. at the Points D and E. From the Points D and E. make the Section F. Draw the Line C F. The Line C O. will be the Line Demanded.

PROPOSITION V.

By a Point given to draw a Line Parallel to a right Line given.

The Position.

Let A be the Point, by the which we must draw a Line, which may be Parallel to the Line B C.

The Practice.

Draw at pleasure the oblique Line A D. from the Point A. Draw the Arch D E. from the Point D. Draw the Arch A F. Make the Arch D G. equal to the Arch A F. Bring the Line demanded M N. by the Points A and G.

See the Queen *of* Diamonds.

Otherwise.

From the Point A. draw the Arch E F G. touching the Line B C.

Without changing the opening of the Compasses.

From the Point H. draw the Arch L R I.

The Point H. *is placed at pleasure within the line* B C.

Draw the Line demanded O P. by the Point A. and grating upon the Arch L R I.

Here endeth the Queen *of* Diamonds.

PROPOSITION VI.

To cut a right Line given, and bounded into two equally.

The Position.

Let A B. be the right Line propounded, to be cut into two equally.

The Practice.

From the point, or end A. draw the Arch C D.

Without changing the opening of the Compasses.

From the point, or end B. draw the Arch E F.

These two Arches must divide each other.

Draw the right Line G H. by the Sections G and H. A B shall be divided into two equally, at the Point O.

See the Knave *of* Diamonds.

PROPO-

PROPOSITION VII.

To cut an Angle Rectilinear given into two equally.

The Position.

Let B A C. be the Angle propounded, to be cut into two equally.

The Practice.

From the Angle A. draw, at pleasure, the Arch D E. From the Points D and E. make the Section O. Draw the Line A O.

This Line A O. shall divide the Angle given B A C. into two equally.

Here endeth the Knave *of* Diamonds.

PROPOSITION VIII.

At the end of a right Line to make an Angle Rectilinear, equal to an Angle Rectilinear proposed.

The Position.

Let A. be the end of the Line A B. to which we must make an Angle, equal to the Angle Rectilinear given C D G.

The Practice.

From the Angle D. draw, at pleasure, the Arch C G.

Without changing the opening of the Compasses.

From the Point, or End A. draw the Arch H O. Make the Arch H E. equal to the Arch C G. Draw the Line A E. The Angle B A E.

See the Ace *of* Harts.

shall be equal to the Angle C D G. the which was propounded to be done.

PROPOSITION IX.

To divide a straight Line given, into as many equal Parts as one will.

The Position.

Let A B. be the Line proposed to be divided into Six equal Parts.

The Practice.

From the end A. draw, at discretion, the Line A C. From the end B. draw the Line B D. parallel to the Line A C. from the Points A and B. and upon the Lines A C B D. Bring, at discretion, six equal Parts, *viz.* E F G H I L. upon the Line A C. R Q P O N M upon the Line B D. Draw the Lines E N. F O. G P. H Q. L R. The Line A B. shall be divided into six equal Parts, by the Sections S. T. V. X. Y.

PROPOSITION X.

From a Point given to draw a straight Line, which toucheth a Circle propounded.

The Position.

Let A. be the Point, from which we must draw a Line which toucheth the Circle D O P.

The Practice.

From the Center of the Circle B. draw the Line Secant B A. Divide this Line B A. into

See the Ace of Harts.

two

two equally in C. from the point C. and the Interval C A. Draw the Demicircle A D B. cutting the Circle in D. from the point given A. Draw the right Line A E. by the point D. This right Line A E. ſhall be the Line touching the required. [*Here endeth the* Ace *of* Harts.

PROPOSITION XI.

To draw a right Line, which toucheth a Circle at a Point propounded.

The Poſition.

Let A B C. be the Circle given, within the Circumference of which, is the Point A. propounded.

The Practice.

From the Point, or Center D. draw the Line D F. by the Point propounded A. at the Point propounded A. and upon the Line D F. Draw the Perpendicular A H. prolonged towards I. This Line Tangent H I. ſhall touch the Circle at the Point propounded A. the which is required by the Propoſition.

PROPOSITION XII.

A Circle being given, and a ſtraight Line that toucheth it, to find the Point where it toucheth.

The Poſition.

Let A B C. be the Circle touched by the Line G H. we muſt find the Point where it toucheth. *See the* Duce *of* Harts.

The Practice.

From the Center of the Circle F. let down the Perpendicular F C. upon the Line touching D E. The Section C. ſhall be the Point of Touching demanded.

PROPOSITION XIII.

To deſcribe a Line Spiral upon a ſtraight Line given.

The Poſition.

Let I L. be the Line, upon which we would deſcribe a Line Spiral.

The Practice.

Page 18. Provide the half of the Line I L. into as many equal Parts, as you would deſcribe the Revolution.

Example.

If you would divide it into Four.

Divide the half B I. into four equal parts B C E G I. Divide alſo B C. into two Page 12. equally at A. From the Point A. draw the Demi-circles B C. D E. F G. H I. From the point B. draw the Demi-circles C D. E F. G H. I L. and you ſhall have the Spiral Line required.

Here endeth the Duce *of* Harts.

PRO-

PROPOSITION XIV.

Between the Points given, to find two other directly interposed.

The Position.

Let A and B. be the Points given, between the which we must find two other Points directly interposed, by the means whereof we may draw a straight Line from the Point A. to the point B. with a short Ruler.

The Practice.

From the Points A and B. make the Sections C and D. From the Points C and D. make the Sections G and H. The Points G and H. shall be the demanded; by the means of which, one may draw three ways a right Line from the point A. to the point B. the which could not be done in one, with a Ruler which should be shorter than the space between A and A.

The Second Part of the Construction of Plain Figures.

PROPOSITION I.

To frame a Triangle Equilateral upon a right Line given, and bounded.

The Position.

Let A B. be the Line given, upon the which we must frame a Triangle Equilateral.

The Practice

From the end A. and the Interval A B. describe the Arch B D. from the end B. and the

See the Tray *of* Harts.

Interval B A. Deſcribe the Arch A E. from the Section C. Draw the Lines C A. C B.

A B C ſhall be the Triangle Equilateral demanded.

PROPOSITION II.

To make a Triangle of three ſtraight Lines, equal to three ſtraight Lines given.

The Poſition.

Let A B C, be the three Lines given, we muſt make a Triangle of three right Lines equal to them.

The Practice.

Draw the right Line D E. equal to the Line A A. from the Point D. and from the Interval B B. Deſcribe the Arch G F. from the point F. and the Interval C C. Deſcribe the Arch H I. from the Section O. Draw the Lines O E, O D. The Triangle D E O. ſhall be compriſed of three right Lines, equal to the three right Lines given A A, B B, C C.

[*Here endeth the* Tray *of* Harts.

PROPOSITION III.

To frame a Square upon one right Line given, and bounded.

The Poſition.

Let A B be the right Line given and bounded, upon the which we muſt frame a Square.

See the Four *of* Harts.

The

The Practice.

Page 4. Elevate the Perpendicular A C. from the point A. Deſcribe the Arch B C. from the Points B and C. and from the Interval A B. Make the Section D. from the point D. Draw the Lines D C, D B. A B C D ſhall be the Square demanded, framed upon the right Line given A B.

PROPOSITION IV.

To frame a Pentagone Regular upon a right Line given.

The Poſition.

Let A B be the Line given, upon the which we muſt frame a Pentagone.

The Practice.

From the end A. and from the Interval A B. Deſcribe the Arch B D F. Elevate the Perpendicular A C. Divide the Arch B C. into five equal Parts I D L M. Draw the right line A D. Cut the Baſes A B. into two equally in O. Elevate the Perpendicular O E. from the Section E. and from the Interval E A. Deſcribe the Circle A B F G H. Bring five times the Line A B. within the circumference of the Circle, and you ſhall have a Pentagone Regular, Equiangle, Equilateral A B F G H.

See the Four *of* Harts.

PRO-

PROPOSITION V.

To frame an Exagone Regular upon a right Line given.

The Position.

Let A B. be the right Line, upon the which we must frame an Exagone.

The Practice.

From the end A and B. and from the Interval A B. Describe the Arches A C, B C. from the Section C. Describe the Circle A B E F G. Bring Six times the Line given A B, within the circumference, and you shall have an Exagone Regular A B E F G D. framed upon the Line given A B.

[*Here endeth the* Four *of* Harts.

PROPOSITION VI.

Upon a right Line given, to describe such a Poligone, as you would have from the Exagone unto the Dodecagone.

The Position.

Let A B be the Line, upon the which that must frame an Exagone, or an Eptagone, or an Octogone, *&c.*

The Practice.

Page 10. Cut the Line A B. into two equally in O. Elevate the Perpendicular O I. From the Point B. describe the Arch A C. Di-

See the Five *of* Harts.

vide

vide A C. into ſix equal parts M N. P Q R. this may make an Eptagone if you will. From the Point C. and the Interval of one part C M. deſcribe the Arch M D. D ſhall be the Center to deſcribe a Circle, capable of containing ſeven times the Line A B.

If you would make an Octogone.

From the point C. and the Interval of two parts C N. deſcribe the Arch N E. E. ſhall be the Center, to deſcribe a Circle capable of containing eight times the Line A B,

If you would make an Enneagone.

You muſt take the three parts C P.

And ſo likewiſe of others, always augmenting it by one part.

[*Here endeth the* Five *of* Harts.

PROPOSITION VII.

Upon a right Line given to frame ſuch a Poligone, *as one would have from* 12 *to* 24 *ſides.*

The Poſition.

Let A B. be the Line, upon the which one would frame any *Poligone.*

The Practice.

Divide the Arch A C. into twelve equal parts, from the point C. Take as many parts upon C A. as there is need above the Twelve, to have as many parts as one requireth of the Sides. [*See the* Six *of* Harts.

Example

Example.

If you make a Figure of fifteen Sides.

From the point C. and from the Interval of three parts C E. describe the Arch E O.

A C of 12, *C O of* 3, *will make together* 15.

From the point O, and the Interval O B. describe the Arch B E. From the point F. and the Interval F A. describe a Circumference, it shall contain fifteen times the Line given A B.

And so of other Poligones.

[*Here endeth the* Six *of* Harts.

PROPOSITION VIII.

Upon a right Line given, to describe a Portion of a Circle, capable of an Angle equal to an Angle given.

The Position.

Let A B. be a Line, bounded upon that which one would make a Portion of a Circle, capable of containing an Angle equal to the Angle given C.

The Practice.

Page 16. Make the Angle B A D. equal to Page 2. the Angle C. Elevate upon A D. the Page 2. Perpendicular A E. Divide the Line A B. into two equally in H. Elevate the Perpendicular H E. from the Section F. and from the Interval F A. Describe the Portion of the Circle A E B. All the Angles that

See the Seven *of* Harts.

you

you ſhall make within the Portion of a Circle, and upon the Line given A B, ſhall be all equal to the Angle C.

PROPOSITION IX.

To find the Center of a Circle given.

The Poſition.

Let A B C. be a Circle propounded, whereof we muſt find the Center.

The Practice.

Draw, at diſcretion, the right Line A B. bounding it ſelf at the Circumference B C. Cut this right Line A B. into two by the Line D C, Cut alſo this right Line C D. into two equally in F. The point F. ſhall be the Center demanded of the Circle A B C.

[*Here endeth the* Seven *of* Harts.

PROPOSITION X.

To finiſh a Circumference begun, whereof the Center is loſt.

The Poſition.

Let A B C. be the part of the Circumference given, we muſt find the Center, that we may finiſh it.

The Practice.

Place, at diſcretion, the three Points A B C. within the circumference begun. From the

See the Eight *of* Harts.

Points

Points A and B. make the Sections E and F. Draw the right Line E F. from the Points B and C. Make the Sections G and H. Draw the right Line G H. From the Intersection and Center I. and from the Interval I A. finish the Circumference began.

PROPOSITION XI.

To describe a Circumference by three Points given.

The Position.

Let A B C. be the three Points, by the which one would pass a Circumference.

The Practice.

From the Points given A B C. describe the three Circles D E H. D E F. F G L. of the same Interval, dividing each other in the points D and E, F and G. Draw the right Lines D E, F G. until that they meet each other in I. From the point I. and the Interval I A. describe the Circumference required.

This Practice is like the former.

[*Here endeth the* Eight *of* Harts.

PROPOSITION XII.

To describe an Oval upon a Length given.

The Position.

Let A B. be the Length, upon the which we must frame an Oval.

See the Nine *of* Harts.

The

The Practice.

Divide the length given A B. into three parts equal A C D B. from the points C and D. and from the Interval C A. Describe the Circles A E F, B E F. from the Sections E and F. and from the Interval of the Diameter E H. Describe the Arches I H, O P. A I H B P O. shall be the Oval required.

Page 18.

PROPOSITION XIII.

To describe an Oval upon two Diameters given.

The Position.

A B, C D. are the Diameters, upon the which we must frame an Oval.

The Practice.

Make the Rule M O. equal to the great half Diameter A E. upon the which you shall make the length M N. equal to the half Diameter C E.

This Rule being so ordered.

Place it so upon the Demands A B. C D. That the point N. sliding upon the line A B. the end O. may never leave the line C D. running on so the said Rule M O. Describe the Oval by the end M.

See the Nine *of* Harts.

PROPOSITION XIV.

To find the Center, and the two Diameters of an Oval.

The Position.

Let A B C D. be the Oval propounded, whereof we must find the Centers, and the Diameters.

The Practice.

Within the Oval propounded A B C D. draw at discretion, the Lines parallels A N. H I. Cut these Lines A N. H I. into two equally in L and M. Draw the Line, P L M O. Cut it into two equally in E. and the point E. shall be already the Center from the Point E. Describe, at discretion, the Circle F H Q. cutting the Oval in F and G. from the Sections F and G. Draw the right Line F G. Cut it into two equally in R. Draw the great Diameter B D. by the Points E R. from the Center E. Draw the less Diameter A E C. parallel to the Line F G.

Pgae 10.

Page 10.

This is it which was propounded.

Here endeth the Nine *of* Harts.

PROPO-

PROPOSITION XV.

To frame a Figure Rectilinear upon a right line bounded, like unto a Figure Rectilinear Propounded.

Let A B. be the line upon the which we must frame a Figure like to the Figure C D E F.

The Practice.

Draw the Diagonal C E. make the Angle B A G. equal to the Angle F C E. make the Angle A B G. equal to the Angle C F E. the triangle A B G. shall be like to the Triangle C F E.

The same.

Make the Triangle A G H. like to the Triangle C E D. the whole Figure A B G H. shall be like to the whole Figure C D E F.

See the Ten of Hearts.

PROPOSITION XVI.

Upon a right line Propounded to frame two Rectangles according to one Reason given.

A B is the line upon which we must frame two Rectangles, which may be between them, according to the reason of C to D.

The Practice.

Cut the line A B. at the point E according to the reason or proportion of C to D. make the square A B, H F. draw the line E I. parallel to the line A F. B E I H, A E I F shall be the Rectangle

D angle

angle required; the Rectangle A I. is to the Rectangle E. H. as the line D. is to the line C.

See the Ten *of* Hearts.

PROPOSITION I.

Within a Circle given to inscribe a Triangle Equilateral, an Exagone and a Dodecagone.

Let A B G. be the Circle, within which we must inscribe a Triangle Equilateral, *&c.*

The Practice.

Of the Triangle Equilateral.

From the point, as A. and from the interval of the half Diameter A B. describe the Arch C B D. draw the right line D C. bring this Interval C D. from the point C. to the point F. Draw the lines F C, F D. C D F shall be the Triangle required.

Of the Exagone.

Bring six times the half Diameter A B. within the circumference given.

Of the Dodecagone.

Cut the Arch of the Exagone A C. into two equally in O. A O shall be the side of the *Dodecagone.*

Here ended the Ten *of* Hearts.

PROPOSITION II.

Within a Circle given to inscribe a Square, and an Octogone.

Let A B C D be the Circle, within the which, one would inscribe a Square and an *Octogone.*

The

The Practice. Of the Square.

Draw the two Diameters A B C D. dividing each other at Right Angles, that is to ſay, draw the right line C D. by the center of the Circle O. from the Points or Ends C and D. Make the Sections I and L. draw the right line I L. paſſing alſo by the Center O. the Lines or Diameters A B, C D. ſhall divide themſelves at right Angles being the lines A C, A D, B C, B D. And A C, B D ſhall be the Square required.

Of the Octogone.

Subdivide every fourth of the Circle, you ſhall make the Octogone.

See the King of Hearts.

PROPOSITION III.

Within a Circle given to inſcribe a Pentagone and a Decagone.

Let A B, C D be the Circle propounded.

The Practice. Of the Pentagone.

Draw the two Diameters A B C D. dividing themſelves at right Angles in E. Divide the half Diameters C E. into two equally in F. from the point F. and from the Interval F A. Deſcribe the Arch A G. from the point A. and from the Interval A G. deſcribe the Arch G H. The righ line A H. ſhall divide the circle into five equal parts.

Of the Decagone.

Subdivide every part of the circle into two equally.

Here endeth the King of Hearts.

PROPOSITION IV.

Within a Circle given to inſcribe an Eptagone.

Let A B C be the circle propounded, within the which we muſt make an *Eptagone.*

The Practice.

Draw the half Diameter I A. from the end A. and from the Interval A I. deſcribe the arch C I C. draw the right line C C. bear the half C O. ſeven times within the circumference of the circle, you ſhall have the *Eptagone* required.

See the Queen *of* Hearts.

PROPOSITION V.

Within a Circle given to deſcribe an Enneagone.

Let BCD be a circle propounded, within which one would inſcribe an Enneagone.

The Practice.

Draw the half Diameter A B. from the end B. and from the Interval B A. Deſcribe the Arch C A D. draw the right line C D. enlarged towards F. make the line E F. equal to the line A B. from the point E. Deſcribe the Arch F G. from the Point F. Deſcribe the Arch E G. draw the right line A G. D H, ſhall be the Ninth part of the circumference.

Here endeth the Queen *of* Hearts.

PRO-

PROPOSITION VI.

Within a Circle given to inscribe an Endecagone.

Let A E F be the Circle given, within which we must inscribe an *Endecagone.*

The Practice.

Draw the half Diameter A B. divide the half Diameter A B. into two equally in C. from the points A and C. and from the Interval A C. Describe the Arches C D I, A D. from the point I. and from the Interval I D. Describe the Arch D O. the Interval C O. shall be the side of the *Endecagone*, required very punctually.

See the Knave of Hearts.

PROPOSITION VII.

Within the Circle given to inscribe such a Poligone as one would.

The Practice.

Draw the Diameter A B. describe the circle A B F. capable to contain seven times A B. as if you would frame upon A B. a Poligone like to that which you should inscribe within the circle given A B C. Draw the Diameter D E. parallel to the Diameter A B. draw the right lines D A G, F B H. by the ends D A, E B. G H shall divide the circle given A B C. into seven equal parts: And so of all other Poligones.

Here endeth the Knave *of* Hearts.

PROPOSITION VIII.

From a Circle given, to take a Portion Capable of an Angle, equal to an Angle Rectilinear propounded.

Let A C E be the Circle given from which we must take a Portion capable to contain an Angle equal to the Angle D.

The Practice.

Draw the half Diameter A B. bring the line touching A F. make the Angle F A C. equal to the Angle given D. All the Angles which shall be framed upon the line A C. and within the portion A E C. shall be all equal to the Angle given D. so the portion A E C. is the required.

See the Ace *of* Spades.

PROPOSITION IX.

Within a Circle to inscribe a Triangle of equal Angles to a Triangle given.

Let A B C be the Circle within the which we must inscribe a Triangle like to the Triangle D E F.

The Practice.

Bring the line touching G H. from the point of the touching A. make the Angle H A C. equal to the Angle E. make also the Angle G. A B. equal to the Angle D. Draw the line B C. A B C is the Triangle required like to the Triangle given D E F.

See the Ace *of* Spades.

PRO-

PROPOSITION X.

To inſcribe a Circle within a Triangle given.

Let A B C be the Triangle, within the which we muſt inſcribe a circle.

The Practice.

Divide the two Angles B and C. each into two equally, by the right lines B D, C D. From the Section D. bring down the perpendicular D F. From the Section or Center D. and from the Interval D F. deſcribe the circle demanded E F G.

Here endeth the Ace *of* Spades.

PROPOSITION XI.

To inſcribe a Square within a Triangle given.

Let A B C be the Triangle, within the which we muſt inſcribe a ſquare.

The Practice.

Elevate the perpendicular A D. at the end of the Baſis A B. make this perpendicular A D. equal to the baſis A B. From the Angle C. draw the line C E. parallel to the line A D. Bring the oblique line D E. from the ſection F. draw the line F G. parallel to the baſis A B. draw the lines F H, G I. parallel to the line C E, F G, H I ſhall be the Square required.

See the Deux *of* Spades.

PROPOSITION XII.

To inscribe a Pentagone Regular within a Triangle Equilateral.

Let A B C be the Triangle, within the which one would inscribe a *Pentagone.*

The Practice.

Bring down the Perpendicular A I. from the center A. describe the Arch BIM. divide into five equal parts the Arch B I. bring the sixth I M. draw the line A M. divide A M. into two equally in L. from the point A. describe the Arch L D. draw the right line L D, unto H. Make the part A G. equal to the part BH. draw the right line DG, MC. from the center D. and from the Interval of the section N. describe the Arch N O. from the points N and O. describe the Arches DQ, D P. draw the lines O P, PQ, NQ. DOP QN shall be the Pentagone required.

See the Deux *of* Spades.

PROPOSITION XIII.

To inscribe a Triangle Equilateral within a square.

Let ABCD be the square, within the which we must make a Triangle Equilateral.

The Practice.

Draw the Diagonals AC, BD. from the Center E. and from the Interval E A. describe the circle A B C D. from the point C. and the Interval C E. Describe the Arch G E F. draw the

the right lines A F, A G. bring the right line H I. A H L ſhall be the Triangle Equilateral, required.

Here endeth the Deux *of* Spades.

PROPOSITION XIV.

To inſcribe a Triangle Equilateral within a Pentagone.

Let A B C D E be the Pentagone, within the which we muſt inſcribe a Triangle Equilateral.

The Practice.

Circumſcribe the circle A B C D E. from the point A. and from the Interval of the half Diameter A F. deſcribe the Arch F L. divide this Arch F L. into two equally in N. draw the line A N I. from the point A. and from the Interval A I. deſcribe the Arch I O H. draw the lines A H, H I. A H I ſhall be the Triangle demanded.

See the Trois *of* Spades.

PROPOSITION XV.

To inſcribe a Square within a Pentagone.

Let A B C D E be the Pentagone, within the which we muſt inſcribe a ſquare.

The Practice.

Draw the right line B E. let down the Perpendicular E T. at the end of B E. make this Perpendicular E T. equal to the line B E. draw the line E T. from the ſection O. bring the

line

line O P. parallel to the side C D. at the end O P. Elevate the perpendiculars O M, P I. draw the line N M. N M O P shall be the square required.

Here endeth the Trois *of* Spades.

PROPOSITION I.

About a Triangle given to Circumscribe a Circle.

LEt A B C be the Triangle, about the which one would circumscribe a Circle.

The Practice.

Describe the circumference A B C. by the three Points A, B, C. and you shall have the demanded.

See the Four *of* Spades.

PROPOSITION II.

About a Square to Circumscribe a Circle.

Let A B C D be the Square about which we must circumscribe a Circle.

The Practice.

Draw the two Diagonals A B C D. from the section or Center G. and from the Interval G A. describe the circle demanded A B C D.

See the Four *of* Spades.

PROPOSITION III.

About a Circle to circumscribe a Triangle of equal Angles to a Triangle given.

Let D E V be the Circle, about the which we must make a Triangle which may be like to the Triangle F G H.

The

The Practice.

Draw the Diameter A B. by the center C. make the Angle A C E. equal to the Angle H. make the Angle B C D. equal to the Angle G. prolong the lines E C, D C. towards R and S. draw the line Tangent N O. parallel to the line D R. draw the line Tangent O I. parallel to the line E S. draw alſo the line Touchant N I. parallel to the Diameter A B. I N O ſhall be the Triangle demanded, like to the Triangle F G H, circumſcribed about the circle, D E V.

Here endeth the Four *of* Spades.

PROPOSITION IV.

About a Circle to circumſcribe a Square.

Let A B C D be the circle, about the which we muſt deſcribe a Square.

The Practice.

Draw the Diameters A B, C D. dividing themſelves at right Angles in O. From the points A, C, B, D, and from the Interval A O. deſcribe the Demicircles H O G, H O E, E O F, F O G, draw the right lines E F, F G, G H, H E, by the Section E, F, G, H. E F G H ſhall be the ſquare demanded.

See the Five *of* Spades.

PRO-

PROPOSITION V.

About a Circle given to circumscribe a Pentagone.

The Practice.

Let A B C D E be the Circle given, about the which one would describe a Pentagone.

Inscribe the Pentagone A B C D E. from the center F. and by the midst of each of the sides draw the lines F O, F P, F Q, F R, F S. bring the line F A. draw the line Tangent P Q. by the point A. from the center F. and from the Interval F. P. describe the circle O P Q R S. draw the sides of the Pentagone, demanded by the Section O P Q R S.

See the Five *of* Spades.

PROPOSITION VI.

About a Poligone Regular to circumscribe the same Poligone.

Let B C D E F G be the Poligone given, about the which we must circumscribe another Poligone like.

The Practice.

Prolong two sides as B G E F. unto the point of the meeting H. draw the line A H. draw the line F I. dividing the Angle G F H. into two equally from the center A. and from the Interval A I. describe the circle I M O. draw the Rays A L, A M, A N, A O; by the midst of each sides, draw the sides of the outward Poligone demanded by the Sections I L M N O P. *See the* Five *of* Spades.

PRO-

PROPOSITION VII.

About a Triangle Equilateral to Circumframe a Square.

Let A B C be a Triangle Equilateral, about the which we muſt circumſcribe a Square.

The Practice.

Divide the Baſis B C. into two equally in E. prolong this Baſis B C. the one part and the other towards D and D. Make the Lines E D, E D. equal to the line E A. From the point E. and from the Interval E C. deſcribe the Demy-circle B F C. draw the line A E F. from the point F. draw the lines F C G, F B G. A G F G ſhall be the Square demanded.

Here endeth the Five *of* Spades.

PROPOSITION VIII.

About a Triangle given Equilateral to circumſcribe a Pentagone.

Let A B C be the Triangle given, about the which we muſt deſcribe a pentagone.

The Practice.

From the Point or Angle A B C. and with the ſame opening of the Compaſſes, deſcribe at diſcretion the Arch D E, L P. divide the Arch D O. into five equal parts, 1 2 3 4 5. From the center or ſection O. and from the Interval of 4 parts O N. deſcribe the Arch N M E. draw the right line A E F. divide the Arch M P. equal to the Arch E N. draw the right line F P C G. equal to the line F A. make

make the arch D H. equal to the Arch D E. draw the sides A I, I R. equal to the sides A F, F G. the side G R shall finish the Pentagone demanded.

See the Sixth *of* Spades.

PROPOSITION IX.

About a Square to circumscribe a Triangle of equal Angles to a Triangle given.

Let D E F G be the Square, about the which we must circumscribe a Triangle like to the Triangle A B C.

The Practice.

Make the Angle E F M. equal to the Angle A. make the Angle M E F. equal to the Angle B. prolong the lines M E, M F, D G, towards I and H. M I H shall be the Triangle required, like to the Triangle A B C. and circumscribe about the square given D E F G.

Here endeth the Six *of* Spades.

PROPOSITION X.

About a Square to circumscribe a Pentagone.

Let A B C D be the Square, about the which we must circumscribe a Pentagone.

Prolong the side C B. towards N. divide the side A B. into two equally in R. Elevate the Perpendicular R V. from the points B, D, C. and from the same Interval B R. divide the Arches R N, S T, S T. divide the Arch R N. into five equal parts R H, G F E N. make the Angle R B V. from the opening of two parts R G. make the Angles S C T, S D T. from the opening

opening of one part R H. prolong the lines V B, C T in O. make the line O Q. equal to the line O V. draw the other sides on the same manner, and you shall have the demanded.

See the Seven *of* Spades.

PROPOSITION I.

To find a line which may be a mean proportional between two others.

LEt A and B be the lines, between the which we must find a third which may be proportional to them.

The Practice.

Draw a line Undeterminate G H. make C E. equal to the line A. make E D. equal to the line B. divide C D. into two equally in I. from the point I. and from the Interval I C. describe the Demy-circle C F D. elevate the Perpendicular E F. This line E F. shall be the mean proportional between A and B. according as it is propounded.

Here endeth the Seven *of* Spades.

PROPOSITION II.

There being given the sum of the Extreams, and the mean proportional to discern the Ends and Extreams.

Let A B be the sum of the Ends, that is to say, two Grandeurs or (Greatnesses the one at the end of the other without distinction) whereof the line C is the mean proportional,

and

and by the means of which we must find the point where the Extreams or Ends do joyn themselves.

The Practice.

Divide the sum or the line A B. into two equally in G. from the point G. and from the Interval G A. describe the Demy-circle A E B. Elevate the perpendicular B D. equal to the mean C. draw the line D E. parallel to the line A B. From the section E. draw the line E F. parallel to the line B D. F shall be the point where the Extreams join themselves, and so C or his equal E F. shall be the mean between the Extreams A F, and F B.

See the Eighth *of* Spades.

PROPOSITION III.

There being given the mean of three Proportionals, and the difference of the Extreams (or Ends) to find the Extreams.

Let G H be the mean Proportional, and A B the difference of the Extreams, we must find the length of the Extreams.

The Practice.

Elevate the perpendicular B C. at the end of the difference A B. and equal to the mean G H. divide the difference A B. into two equally in D. prolong it towards E and F. from the point D. and from the interval D C. describe the Demy-circle E C F. B E, B F shall be the Extreams demanded.

Here endeth the Eight *of* Spades.

PROPOSITION IV.

From a right line given, to cut off a part, which may be a mean proportional between the rest, and another right line Propounded.

Let A A be the line, from the which we must cut off a part, which may be the mean proportional between the part that shall remain, and the line proposed B B.

The Practice.

Draw the line Indeterminate C D. divide the lines D E, E C. equal to the lines A A and B B. describe the Demy-circle C F D. elevate the perpendicular E F. divide the line C E. into two equally in B. from the point B. and from the interval B F. describe the Arch F G. divide the part demanded A G. equal to the part E G. A H. shall be the mean proportional between the rest H I. and the other line propounded B B.

See the Nine *of* Spades.

PROPOSITION V.

There being given two right lines, to find a Third Proportional.

A B, A C are the two right lines given, we must find a third, which may be proportional to them.

The Practice.

Make at discretion the Angle D N E. divide the part N H. equal to the line A B. divide

vide the part N O. equal to the line A C. divide alſo H D. equal to the line A C. bring the line H O. draw the line D E. parallel to the line H O. E O ſhall be third proportional demanded.

Here endeth the Nine *of* Spades.

PROPOSITION VI.

To find a fourth Proportional.

A, B, C, are the three lines propoſed, we muſt find a fourth which may be to the third, as the ſecond to the firſt.

The Practice.

Make at diſcretion the Angle G D H. divide the part D E. equal to the line A. divide the part D F, equal to the line B. divide the part E G. equal to the line C. bring the line E F. draw the line G H. parallel to the line E F. F H ſhall be fourth proportional demanded.

See the Ten *of* Spades.

PROPOSITION VII.

Between two right lines given to find two means proportional.

Let I and H be the lines propounded, between the which we muſt find two mean proportional.

The Practice.

Draw the line A B. equal to the line H. let down the Perpendiculars B C. equal to the line

line I. bring the line A C. divide this line A C. into two equally in F. elevate the Perpendiculars A O, C R. From the point or center F. describe the Arch D E. in such manner that the Cord D E. touch the Angle B. A D, C E shall be the means proportional between the lines given I and H.

Here endeth the Ten *of* Spades.

PROPOSITION VIII.

To divide two right lines given, each into two parts, so that the four Segments may be proportional.

A B, A C are the lines propounded to be.

The Practice.

Make the right Angle B O C. divide the line B O. equal to the line A B. divide the line O C. equal to the line A C. bring the subtendent B C. describe the Demy-circle B D O. from the section D. bring the line D E. parallel to the line C O. the line D F. parallel to the line E O. A B shall be divided in E. O C shall be divided in F. So that B E shall be to E D as E D is to D F, and E D to D F as D F is to F C.

Here endeth the King *of* Spades.

PROPOSITION IX.

There being given the Excess of the Diagonal of a square, about the side to find the greatness of the said side.

Let A B be the Excess of the Diagonal of a square, above its side whereof we must find the greatness.

The Practice.

Elevate the perpendicular B C. equal to the Excess B A. draw the line A C. prolonged towards D. from the point C. and from the interval C B, describe the Arch B D, A D shall be the side of the square, whereof A B is the Excess of the Diagonal A E, above the said side A D.

See the Queen *of* Spades.

PROPOSITION X.

To divide a right line Terminated within the mean and extream reason.

Let A B be the line, which we must divide in such manner, as the Rectangle composed of the whole line, and of one of the two parts, may be equal to the square framed upon the other part.

The Practice.

Elevate the perpendicular A D. prolong it towards D. make A C. equal to the half of A B. from the point C. and from the Interval C B. describe the Arch B D. from the point A. and

and from the interval A D. describe the Arch E. The line A B. shall be divided in E. according to the proposition; for if you make the Rectangle A H of the whole A B, and of the part B E, it shall be equall to the square A F. framed upon the other part A E.

Here endeth the Queen *of* Spades.

PROPOSITION XI.

To divide a right line terminated according to the reasons given.

Let A B be the line propounded, to be divided according to the Reasons, C. D. E. F.

The Practice.

From the point or end A. draw at discretion the line A G. make A H. equal to the line or reason C. make H I. equal to the line D. make I L. equal to the line E. make L M. equal to the line F. draw the line B M. bring the lines L N, I O, H P. parallels to the line B M. the line A B shall be divided in the points P O N, according as it is demanded.

Here endeth the Knave *of* Spades.

Mechanick Powers:

OR, A

MANUSCRIPT

OF

Monsi. Des-Cartes.

The Explication.

Of Engines, by help of which we may raise a very great Weight with small Strength.

THE invention of all these Engins depends upon one sole Principle, which is, that the same Force that can lift up a Weight, for Example, of 100 *l.* to the height of one Foot, can lift up one of 200 *l.* to the height of half a Foot, or one of 400 *l.* to the height

height of a fourth part of a Foot, and ſo of the reſt, be there never ſo much applied to it; and this Principle cannot be denied, if we conſider, that the Effect ought to be proportioned to the Action that is neceſſary for the Production of it: So that if it be neceſſary to employ an Action, by which we may raiſe a Weight of 100*l.* to the height of two foot, for to raiſe one ſuch to the height of one foot only; this ſame ought to weigh 200*l.* for it's the ſame thing to raiſe 100*l.* to the height of one foot, and again, yet another 100*l.* to the height of one foot, as to raiſe one of 200*l.* to the height of one foot, and the ſame, alſo, as to raiſe 100*l.* to the height of two feet.

Now the Engines which ſerve to make this Application of a Force, which acteth at a great ſpace upon a Weight which it cauſeth to be raiſed by a leſſer, are the Pulley, the inclined Plane, the Wedge, the Capſten, or Wheel, the Screw, the Lever, and ſome others; for if we will not apply or compare them one to another, we cannot well number more, and if we will apply them, we need not inſtance in ſo many.

The Pulley, Trochlea.

Let A B C be a Chord put about the Pulley D, to which let the Weight E be faſtned;

and first, supposing that two Men sustain or pull up equally each of them one of the ends of the said Chord, it is manifest, that if the Weight weigheth 200 *l.* each of those Men shall employ but the half thereof, that is to say, the force that is requisite for sustaining or raising of 100 *l.* for each of them shall bear but the half of it.

Afterwards, let us suppose that A, one of the ends of this Chord, being made fast to some Nail, the other C be again sustained by a Man; and it is manifest, that this Man in C, needs not (no more than before) for the sustaining the Weight E, more force than is requisite for the sustaining of 100 *l.* because the Nail at A doth the same Office as the Man which we supposed there before; in fine, let us suppose that this Man in C do pull the Chord to make the Weight E to rise, and it is manifest, that if he there employeth the force which is requisite for the raising of 100 *l.* to the height of two foot, he shall raise this Weight E of 200 *l.* to the height of one foot; for the Chord ABC being doubled, as it is, it must be pulled two feet by the end C, to make the Weight E rise as much, as if two men did draw it, the one by the end A, and the other by the end C, each of them the length of one foot only.

There's always one thing that hinders the exactness of the Calculation, that is the pon-

perosity

perosity of the Chord or Pulley, and the difficulty that we meet with in making the Chord to slip, and in bearing it: But this is very small in comparison of that which raiseth it, and cannot be estimated, save within a small matter.

See the Ace *of* Clubs.

Moreover, its necessary to observe, that its nothing but the redoubling of the Chord, and not the Pulley, that causeth this force; for if we fasten yet another Pulley towards A, about which we pass the Chord A B C H, there will be required no less force to draw H towards K, and so to lift up the Weight E, than there was before to draw C towards G. But if to these two Pulleys we add yet another towards D, to which we fasten the Weight, and in which we make the Chord to run or slip, just as we did in the first, then we shall need no more force to lift up this Weight of 200 *l.* than to lift up 50 *l.* without the Pulley; because that in drawing four foot of Chord we lift it up but one foot, and so in multiplying of the Pulleys, one may raise the greatest Weights with the least Forces. Its requisite also to observe, that a little more Force is always necessary for the raising of a Weight than for the sustaining of it, which is the reason why I have spoken here distinctly of the one and the other.

The

The inclined Plane.

If not having more Force than ſufficeth to raiſe 100 *l.* one would neverthelеſs raiſe this body F, that weigheth 200 *l.* to the height of the line B A, there needs no more but to draw or rowl it along the inclined Plane C A, which I ſuppoſe to be twice as long as the line A B; for by this means, for to make it arrive at the point A, we muſt there employ the Force that is neceſſary for the raiſing 100 *l.* twice as high; and the more inclined this Plane ſhall be made, ſo much the leſs Force ſhall there need to raiſe the Weight F. But yet there is to be rebated from this Calculation, the difficulty that there is in moving the body F, along the plane A C, if that plane were laid down upon the line B C, all the parts of which I ſuppoſe to be equidiſtant from the Center of the Earth.

It is true, that this impediment being ſo much leſs as the Plane is more united, more hard, more even, and more polite, it cannot likewiſe be eſtimated but by gueſs, and it is not very conſiderable. Neither need we much to regard that the line B C being a part of a Circle that hath the ſame Center with the Earth, the plane A C ought to be (though but very little) curved, and to have the Figure of part of a Spiral, deſcribed beteen two

Circles,

Circles, which also have for their Center that of the Earth, for that it is not any way sensible.

The Wedge, Cuneus.

The force of the Wedge A B C D is easily understood after that which hath been spoken above of the inclined Plane, for the force wherewith we strike downwards, acts as if it were to make it move according to the line B D; and the Wood, or other thing and body that it cleaveth, openeth not, or the Weight that it raiseth doth not rise, save only according to the line A C; insomuch that the force, wherewith one driveth or striketh this Wedge, ought to have the same proportion to the resistance of this Wood or Weight, that A C hath to A B. Or else again, to be exact, it would be convenient that B D were a part of a Circle, and A D and C D two portions of Spirals that had the same Center with the Earth, and that the Wedge were of a matter so perfectly hard and polite, and of so small weight, as that any little force would suffice to move it.

The Crane, or the Capsten, Axis in Peritrochio.

We see also very easily, that the force wherewith the Wheel A or Cogg B is turned, which make the Axis or cylinder C to move, about which a Chord is rowled, to which the weight

D, which we would raise is fastned, ought to have the same proportion to the said Weight, as the circumference of the Cylinder hath to the circumference of a Circle which that force describeth, or that the Diameter of the one hath unto the Diameter of the other; for that the circumferences have the same proportion, as the Diameters; in so much that the Cylinder C, having no more but one foot in Diameter, if the Wheel A B be six feet in its Diameter, and the Weight D do weigh 600 *l.* it shall suffice that the force in B shall be capable to raise 100 *l.* and so of others. One may also instead of the Chord that rolleth about the Cylinder C, place there a small Wheel with Teeth or Coggs, that may turn another greater, and by that means multiply the power of the force as much as one shall please, without having any thing to deduct of the same, save only the difficulty of moving the Machine, as in the others.

Here endeth the Ace *of* Clubs.

The Screw, Cochlea.

When once the force of the Capsten and of the inclined Plane is understood, that of the Screw is easie to be computed, for it is composed only of a Plane much inclined, which windeth about a Cylinder; and if this Plane be in such manner inclined, as that the Cylinder ought to make v. gr. ten turns to advance forwards the

the length of a foot in the Screw, and that the bigneſs of the circumference of the Circle which the force that turneth it about doth deſcribe, be of ten feet, for as much as ten times ten are an Hundred; one Man alone ſhall be able to preſs as ſtrongly with this Inſtrument, or Screw, as one Hundred without it, provided always, that we rebate the force that is required to the turning of it.

Now I ſpeak here of preſſing rather than of raiſing, or removing, in regard that it is about this moſt commonly that the Screw is employed; But when we would make uſe of it for the raiſing of Weights, inſtead of making it to advance into a Female Screw, we joyn or apply unto it a Wheel of many Coggs, ſo made, that if v. gr. this Wheel have thirty Coggs, whilſt the Screw makes one entire turn, it ſhall not cauſe the Wheel to make more than the 30*th.* part of a turn, and if the Weight be faſtned to a Chord, that rowling about the Axis of this Wheel ſhall raiſe it but one foot in the time that the Wheel,makes one entire revolution, and that the greatneſs of the circumference of the Circle that is deſcribed by the force that turneth the Screw about, be alſo of ten foot, by reaſon that ten times 30 makes 300; one ſingle Man ſhall be able to raiſe a Weight of that bigneſs with this Inſtrument, which is called the perpetual Screw, as would require 300 Men without it.

Provided as before, that we thence deduct the difficulty that we meet with in turning of it, which is not properly caused by the Ponderosity of the Weight, but by the force or matter of the Instrument, which difficulty is more sensible in it than in those aforegoing, for as much as it hath greater force.

The Leaver, Vectis.

I have deferred to speak of the Leaver until the last, in regard that it is of all Engines for raising of Weights, the most difficult to be explained.

Let us suppose that C H is a Leaver, in such manner supported at the point O, (by means of an Iron Pin that passes through it across, or otherwise) that it may turn about on this point O; its part C describing the semicircle A B C D E, and its part H the semicircle F G H I K, and that the Weight which we would raise by help of it were in H, and the force in C, the line C O being supposed triple of O H. Then let us consider that in the time whilst the force that moveth this Leaver, describeth the whole semicircle A B C D E, and acteth according to the line A B C D E, although that the Weight describeth likewise the semicircle F G H I K, yet it is not raised to the length of this curved line F G H I K, but only that of the line F O K, insomuch that the

the proportion that the Force which moveth this Weight ought to have to its Ponderosity, ought not to be measured by that which is between the two Diameters of these Circles, or between their two circumferences, as it hath been said above of the Wheel, but rather by that which is betwixt the circumference of the greater, and the Diameter of the lesser. Furthermore let us consider, that there is a necessity that this Force needeth not to be so great, at such time as it is near to A, or near to E, for the turning of the Leaver, as then when it is near to B or to D; nor so great when it is near to B or to D, as then when it is near to C. of which the reason is, that the Weights do there mount less, as it is easie to understand; if having supposed that the line C O H is parallel to the Horizon, and that A O F cutteth it at right Angles, we take the point G equidistant from the point F and H, and the point B equidistant from A and C. and that having drawn G S perpendicular to F O, we observe that the line F S (which sheweth how much the Weight mounteth in the time that the force operates along the line A B) is much lesser than the line S O, which sheweth how much it mounteth in the time that the force operates along the line B C.

And to measure exactly what his force ought to be in each point of the curved line A B C D E, it is requisite to know that it operates there

there just in the manner as if it drew the Weight along a plane circularly inclined, and that the inclination of each of the points of this circular plane were to be measured by that of the right line, that toucheth the circle in this point. As for Example, when the force is at the point B, for to find the proportion that it ought to have with the Ponderosity of the Weight which is at that time at the point G, its necessary to draw the Tangent line G M, and to account that the ponderosity of the Weight is to the force which is required to draw it along this plane, and consequently to raise it, according to the circle F G H, as the line G M is to S M. Again, for as much as B O is triple of O G, the force in B needs to be to the Weight in G, but as the $\frac{1}{3}$ of the line S M is to the whole line G M. In the self same manner, when the force is at the point D, to know how much the Weight weigheth at I, its necessary to draw the Contingent line betwixt I and P, and the right line I N perpendicular to the Horizon, and from the point P taken at discretion in the line I P, provided that it be below the point I, you must draw *P N* parallel to the same Horizon, to the end you may have the proportion that is betwixt the line I P and the $\frac{1}{3}$ of I N, for that which is betwixt the ponderosity of the Weight, and the force that ought to be at the point D for the moving of it, and so of o-

others:

thers: Where, neverthelesſ you muſt except the point H, at which the contingent line being perpendicular to the Horizon, the weight can be no other than triple the force which ought to be in C for the moving of it; in the points F and K, at which the contingent line being parallel to the Horizon it ſelf, the leaſt force that one can aſſign is ſufficient to move the Weight. Moreover, that you may be perfectly exact, you muſt obſerve that the lines S M and P N ought to be parts of a circle that have for their center that of the Earth; and G M and I P part of Spirals drawn between two ſuch Circles, and laſtly, that the right lines S M and I N both tending towards the center of the Earth are not exactly parallels: And furthermore, that the point H where I ſuppoſe the contingent line to be perpendicular to the Horizon, ought to be ſome ſmall matter nearer to the point F than to K, at the which F and K the contingent lines are parallels to the ſaid Horizon.

This done, we may eaſily reſolve all the difficulties of the Balance, and ſhew, that then when its moſt exact, and for inſtance, ſuppoſing its center at O by which it is ſuſtained, to be no more but an indiviſible point, like as I have ſuppoſed here for the Leaver, if the arms be declined one way or the other, that which ſhall be the lowermoſt ought evermore to be adjudged the heavier; ſo that the center of Gravity is not fixt and immovable in each ſe-

veral body, as the Ancients have ſuppoſed, which no Perſon that I know of hath hitherto obſerved.

But theſe laſt conſiderations are of no moment in Practice, and it would be good for thoſe who ſet themſelves to invent new Machines, that they knew nothing more of this buſineſs, than this little which I have now writen thereof, for then they would not be in danger of deceiving themſelves in their computation, as they frequently do in ſuppoſing other Principles.

See the Deux *of* Clubs.

A

A LETTER OF Monsi. Des-Cartes

To the Reverend Father *Marin Mersenne.*

Reverend Father,

I Did think to have deferred Writing to you yet 8 or 15 days, to the end I might not trouble you too often with my Letters, but I have received yours of the First of *September*, which giveth me to understand that its an hard matter to admit the principle which I have supposed in my Examination of the Geostatick Question, and in regard that if it be not true, all the rest that I have inferred

from it would be yet less true; I would not only to day defer sending you a more particular Explication. Its requisite above all things to consider, that I did speak of the Force that serveth to raise a Weight to some height, the which Force has overmore two Dimensions, and not of that which serveth in each Point to sustain it, which hath never more than one Dimension, insomuch that these two Forces differ as much the one from the other, as a Superficies differs from a Line; for the same Force which a Nail ought to have for the sustaining of a Weight of 100 *l.* one moment of time, doth also suffice for to sustain it the space of a Year, provided that it do not diminish, but the same Quantity of this Force which serveth to raise the Weight to the height of one foot, sufficeth not (*eadem numero*) to raise it two feet, and its not more manifest that 2 and 2 makes 4, than its manifest that we are to employ double as much therein.

Now, for as much as that this is nothing but the same thing that I have supposed for a Principle, I cannot guess on what the Scruple should be grounded, that Men make of receiving it; but I shall in this place speak of all such as I suspect, which for the most part arise only from this, that Men are beforehand overknowing in the *Mechanicks*; that is to say, that they are pre-occupied with Principles that

that others prove touching these matters, which not being absolutely true, they deceive the more, the more true they seem to be.

The first thing wherewith a Man may be pre-occupied in this business, is, That they many times confound the consideration of Spaces with that of Time, or of the Velocity; so that, for Example, in the Leaver, or (which is the same) the Ballance A B C D, having supposed that the Arm A B is double to B C, and the Weight in C double to the Weight in A, and also that they are in an *Equilibrium*, instead of saying, that that which causeth this *Equilibrium*, is, that if the Weight C did sustain, or was raised up by the Weight A, it did not pass more than half so much space as it; they say, that it did move slower by the half, which is a fault so much the more prejudicial, in that it is very difficult to be known; for it is not the difference of the Velocity that is the cause why these Weights are to be one double to the other, but the difference of the Space, as appeareth by this; that to raise, for Example, the Weight F with with the hand to G, it is not necessary to employ a Force that is precisely double to that which one should have therein employ'd the first bout, to raise it twice as quickly, but its requisite to employ therein either more or less than the double, according to the diffe-

rent proportion of this Velocity may have to the causes that resist it.

See the Deux *of* Clubs.

Instead of requiring a Force just double for the raising of it with the same Velocity twice as high unto H, I say, that it is just double in counting (as two and two make four) that one and one make two, for it is requisite to employ a certain quantity of this Force to raise the Weight from F to G, and again also, as much more of the same Force to raise it from G to H.

For if I had had a mind to have joyned the consideration of the Velocity with that of the Space, it had been necessary to have assigned three dimensions to the Force, whereas I have assigned it no more but two, on purpose to exclude it. And if I have testified that there is so little of worth in any part of this small Tract of the Staticks, yet I desire that Men should know, that there is more in this alone, than in all the rest: For its impossible to say any thing that is good and solid touching Velocity, without having rightly explained what we are to understand by Gravity, as also the whole System of the World. Now because I would not undertake it, I have thought good to omit this consideration, and in this manner to single out these others that I could explain without it; for though there be no motion but hath some Velocity, nevertheless

theless it is only the Augmentations and Diminutions of this Velocity that are considerable. And now that speaking of the motion of a Body, we suppose that it is made according to the Velocity which is most natural to it, which is the same as if we did not consider it at all.

The other reason that may have hindred Men from rightly understanding my Principle, is, that they have thought that they could demonstrate without it some of those things which I demonstrate not without it; As for Example, touching the Pulley ABC, they have thought that it was enough to know that the Nail in A did sustain the half of the Weight B; to conclude that the hand in C had need but of half so much Force to sustain or raise the Weight, thus wound about the Pulley, as it would need for to sustain or raise it without it. But howbeit that this explaineth very well, how the application of the Force at C is made unto a Weight double to that which it could raise without a Pulley, and that I my self did make use thereof, yet I deny that this is simply, because that the Nail A sustaineth one part of the Weight B, that the Force in C, which sustaineth it, might be less than if it had been so sustained. For if that had been true, the Rope CE being wound about the Pulley D, the Force in E might by the same reason be less than the

Force in C; for that the Nail A doth not sustain the Weight less than it did before, and that there is also another Nail that sustains it, to wit, that to which the Pulley D is fastened,

Thus therefore, that we may not be mistaken in this, that the Nail A sustaineth the half of the Weight B, we ought to conclude no more but this, that by this application the one of the Dimensions of the Forces that ought to be in C to raise up this Weight is diminished the one half, and that the other of consequence becometh double, in such sort that if the line F G represent the Force that is required for the sustaining the Weight B, in a point, without the help of any Machine, and the Quadrangle G H that which is required for the raising of it to the height of a foot, the support of the Nail A diminisheth the Dimension which is represented by the line F G the one half, and the redoubling of the Rope A B C maketh the other Dimension to double, which is represented by the line F H, and so the Force that ought to be in C, for the raising of the Weight B to the height of one foot, is represented by the Parallelogram I K; And as we know in Geometry, that a line being added to, or taken from a superficies, neither augmenteth, nor diminisheth it in the least, so the Force wherewith the Nail A sustains the Weight B, having but one sole Dimension, cannot cause that the Force in C,

con-

considered according to its two Dimensions, ought to be less for the raising in like manner the Weight E, than for the raising it without any Pulley.

Here endeth the Deux *of* Clubs.

The third thing which may make men imagine some obscurity in my Principle is, that they, it may be, have not had regard to all the words by which I explain it; for I do not say simply that the Force that can raise a Weight of 50*l.* to the height of 4 feet can raise one of 200*l.* to the height of one foot; But I say, that it may do it, if so be that it be applied to it: Now its impossible to apply the same, but by the means of some Machine, or other invention that shall cause this Weight to ascend but one, in the time whilst the Force passes the whole length *of 4 feet*, and so that it do transform the Quadrangle, by which the Force is represented, that is required to raise this Weight of 400 *l.* to the height of one foot into another, that is equal and like to that which represents the Force that is required for to raise a Weight of 50 *l.* to the height of 4 feet.

In fine, it may be that Men may have thought the worse of my Principle, because they have imagined that I have alledged the Examples of the Pulley, of the inclined Plane, and of the Leaver, to the end that I might better perswade the truth thereof, as if it had been

been dubious, or else that I had so ill discoursed as to offer to assume from thence a Principle, which ought of it self to be so clear, as not to need any proof by things that are so difficult to comprehend as that; it may be, they have never been well demonstrated by any Man, but neither have I made use of them, save only with a design to shew that this Principle extends it self to all matters of which one treateth in the Staticks; or rather, I have made use of this occasion for to insert them into my Treatise, for that I conceived that it would have been too dry and barren if I had therein spoken of nothing else but of this Question, that is of no use, as of that of the Geostaticks, which I purposed to Examine.

Now one may perceive by what hath already been said, how the Forces of the Leaver and Pulley are demonstrated by my principle so well, that there only remains the inclined plane, of which you shall clearly see the demonstration by this Figure, in which G F represents the first Dimension of the Force that the Rectangle F H describeth, whilst it draweth the Weight D along the plane B A, by the means of a Chord parallel to this plane, and passing about the Pulley E, in such sort that H G, that is the height of this Rectangle, is equal to B A, along which the Weight D is to move, whilst it mounteth to the height of the line C A. And N O represents the first

Di-

Dimension of such another Force, that is described by the Rectangle N P, in the time that it is raising the Weight L to M.

And I suppose that L M=B A=2C A, and that NO-. F G::O P-G H. This done, I consider that at such time as the Weight D is moved from B towards A, one may imagine its motion to be composed of two others, of which the one carrieth it from B R towards C A, (to which operation there's no Force required, as all those suppose who treat of the Mechanicks) and the other raiseth it from B C towards R A, for which alone the Force is required, in so much that it needs neither more nor less Force to move it along the inclined plane B A, than along the perpendicular C A. For I suppose that the unevenness, *&c.* of the Plane do not at all hinder it, like as it is always supposed in treating of this matter:

So then the whole Force F H is employed only about the raising of D to the height of C A, and for as much as it is exactly equal to the Force N P, that is required for the raising of L to the height of L M, double to C A, I conclude by my principle that the Weight D is double to the Weight L. For in regard that it is necessary to employ as much Force for the one as for the other, there is as much to be raised in the one as in the other, and no more knowledge is required than to count unto

unto two for the knowing that it is alike facile to raise 200 *l.* from C to A, as to raise 100 *l.* from L to M, since that L M=2C A.

See the Trois *of* Clubs.

You tell me moreover, that I ought more particularly to explain the nature of the Spiral Line that representeth the plane equally enclined, which hath many qualities that render it sufficiently knowable.

For if A be the Center of the Earth, and A N B C D the Spiral Line, having drawn the Right Lines A B, A D, and the like, there's the same proportion betwixt the Curved Line A N B, and the Right Line A B, as is betwixt the Curved Line A N B C, and the Right Line A C; or betwixt A N B C D and A D; and so of the rest.

And if one draw the Tangents D E, C F, and B G, the Angles A D E, A C F, A B G, &c. shall be equal. As for the rest I will, *&c.*

Reverend Father,

Your very humble Servant,

Des-Chartes.

A LETTER OF Monsi. de Robberal TO Monsi. de Fermates, COUNSELLOR OF *THOULOUSE*, CONTAINING Certain Propositions in the Mechanicks.

Monsieur,

I Have according to my promise, sent you the Demonstration of the fundamental proposition of our Mechanicks, in which I follow the common method of explaining in the

the first place, the Definitions and Principles of which we make use.

We in general call that quality a Force or Power, by means of which any thing whatever doth tend or aspire into another place than that in which it is, be it downwards, upwards, or side-ways, whether this Quality naturally belongeth to the Body, or be communicated to it from without. From which definition it followeth, that all Weights are a Species of Force, in regard that it is a Quality, by means whereof Bodies do tend downwards. We often also assign the name of Force to that very thing to which the Force belongeth, as a ponderous Body is called Weight; but with this pre-caution, that this is in reference to the true Force, the which augmenting or diminishing shall be called a greater or lesser Force, albeit that the thing to which it belongeth do remain always the same. If a Force be suspended or fastened to a flexible Line that is without Gravity, and that is fastened at one end to some Fulciment or Stay, in such sort as that it sustain the Force, drawing without impediment by this line, the Force and the line shall take some certain position in which they shall rest, and the line shall of necessity be straight, let the line be termed the *Pendant*, or *line of Direction of the Force*; and let the point by which its fastned to the Fulciment be called the *point of Suspension*; which may sometimes be the

Arm

Arm of a Leaver or Ballance, and then let the line drawn from the Center of the Fulciment of the Leaver or Ballance to the point of suspension be named the *Distance or the Arm of the Force*, which we suppose to be a line fixed, and considered without Gravity.

Moreover, let the Ang. comprehended betwixt the Arm of the Force and the line of Direction be termed, *the Ang. of the Direction* of the Force.

Axiom 1.

After these Definitions we lay down for a Principle, that in the Leaver, and in the Ballance, equal Forces drawing by Arms that are equal, and at equal Angles of Direction, to draw equally. And if in this Position they draw one against the other, they shall make an Equilibrium; but if they draw together, or towards the same part, the Effect shall be double. If the Forces being equal, and the Angles of Direction also equal, the Arms be unequal, the Force that shall be suspended at the greater Arm shall work the greater Effect.

As in this Figure, the Center of the Ballance or Leaver being A, if the Arms A B and A C are equal, as also the Angles A B D, and A C E, the equal Forces D and E shall draw equally, and make an Equilibrium. So likewise the Arm A F being equal to A B, the Ang. A F G

to

to the Ang. A B D, and the Force G to D, these two Forces * G and D shall draw equally, and in regard that they draw both one way, the Effect shall be double. In the same manner the Forces G and F shall make an Equilibrium, as also I and L shall counterpoise, if (being equal) the Arms A K and A H, and the ∡s A H T and A K L be equal.

* *In* M. S. *Coppy its* G *and* D.

The same shall befall in the Forces P and R, if all things be disposed as before. And in this case we make no other distinction betwixt Weights and other Forces save only this, that Weights all tend towards the Center of grave Bodies, and Forces may be understood to tend all towards all parts of the Universe, with so much greater or lesser *impetus* than Weights; so that Weights and their parts do draw by Lines of Direction, which all concur in one and the same point, and Forces and their parts may be understood to draw in such sort, that all the Lines of Direction are parallel to each other.

Axiom 2.

In the second place, we suppose that a Force and its Line of Direction abiding always in the same position, as also the Center of the Ballance or Leaver, be the Arm what it will, that is drawn from the Center of the Ballance to the

the line of Direction, the Force drawing always in the same fashion, will always produce the same effect.

As in the second Figure, the center of the Ballance being A, the Force B, and the line of Direction B F prolonged, as occasion shall require, in which the Arms A G, A C and A F do determine; in this position let the line B F be fastned to the Arm A F or A G, or to another Arm drawn from the center A to the line of Direction * B F; we suppose that this Force B shall always work the same Effect upon the Ballance. And if drawing by the Arm A C it make an Equilibrium with the Force D drawing by the Arm A E, when ever it shall draw by the Arms A F or A G, it shall likewise make an Equilibrium with the Force D, drawing by the Arm A E. This Principle altho' it be not expresly found in Authors, yet it is tacitly supposed by all those that have writ on this Argmument, and experience constantly confirmeth it.

* *In the Original it is writ by the mistake of the Transcriber a la ligne direction* A F.

Axiom 3.

If the Arms of a Ballance or Leaver are directly placed the one to the other, and that being equal they sustain equal Forces, of which the Angles of Direction are right Angles,

these Forces do always weigh equally upon the center of the Ballance, whether that they be neer to the same center, or far distant, or both conjoined in the center it self; as in this Figure the Ballance being E D, the center A, the equal Arms A D and A E, let us sustain equal Forces H and I, of which the Angles of direction A D H and A E I are right Angles, we suppose that these two Forces I and H weigh alike upon the center A as if they were nearer to the center, at the equal distances A B and A C, and we also suppose the same if these very Forces were suspended both together in A, the Angles of Directions being still right Angles.

Here endeth the Trois *of* Clubs.

PROPOSITION I.

THese Principles agreed upon, we will easly demonstrate in imitation of *Archimedes*, that upon a straight Ballance the Forces of which and of all their parts the lines of direction are parallel to one another, and perpendicular to the Ballance, shall counterpoise and make an Equilibrium, when the said Forces shall be to one an other in reciprocal proportion of their Arms, which we think to be so manifest to you, that we thence shall derive the Demonstration of this Universal Proposition, to which we hasten.

PRO-

PROPOSITION II.

IN every Ballance or Leaver, if the proportion of the Forces is reciprocal to that of the perpendicular lines drawn from the center or point of the Fulciment unto the lines of Direction of the Forces, drawing the one against the other, they shall make an Equilibrium, and drawing on one and the same side, they shall have a like effect, that is to say, that they shall have as much Force the one as the other, to move the Ballance. In this Figure let the center of the Ballance be A, the Arm A B, bigger than A C, and first let the lines of Direction B D and E C be perpendicular to the Arms A B and A C, by which lines the Forces D and E (which may be made of Weights if one will) do draw, and that there is the same rate of the Force D to the Force E, as there is betwixt the Arm A C to the arm A B, the Forces drawing one against the other, I say, that they will make an Equilibrium upon the Ballance C A B. For let the Arm C A be prolonged unto F, so as that A F may be equal to A B; and let C A F be considered as a straight Ballance, of which the center be A, and let there be supposed two Forces G and H, of which and of all their parts the lines of Direction are parallel to the line C F, and that the Force G be e-

qual to the Force D, and H to E, the one, to wit, G, drawing up the Arm A F, and the other, to wit, H, upon the Arm A C; now, by the [illegible] Proposition, C and H ſhall make an Equilibrium upon the Ballance C A F, but by the firſt principle, the force D upon the Arm A B furniſheth the ſame effect as the force G by the Arm A F; Therefore the force D upon the Arm A B maketh an Equilibrium with the force H upon A C, and the force H drawing in the ſame manner upon the Arm A G, and the force H the ſame firſt Axiom, the force D upon the Arm A B ſhall make an Equilibrium with the force E upon the Arm A C.

See the Four *of* Clubs.

Now, in the following Figure, let the center *of the* Ballance be A, the arms A B and A C, the lines of *Direction* B D and C E, which are not perpendicular to the arms, and the Forces D and E drawing likewiſe by the lines of Direction, upon which perpendiculars are erected unto the center A, that is A F upon B D, and A G upon E C, and that as A F is to A G, ſo is the force E to the force D; which forces draw one againſt the other, I ſay, that they will make an Equilibrium upon the Ballance C A B; for let the lines A F and A G be underſtood to be the two arms of a Ballance G A F, upon which the forces D and E do draw by the lines of

Direction

Direction I forces shall make an Eq rt of this Proposition, ions, the force D upo same effect as up fore the force D upon an Equilibrium with the n A C. There are many C ne series of perpendiculars, but easie for you to see that they have all but one and the same Demonstration; it is also easie to demonstrate, that if the forces draw both on one side they shall make the same effect one as another, and that the effect of two together shall be double to that of one alone.

Here endeth the Four of Clubs.

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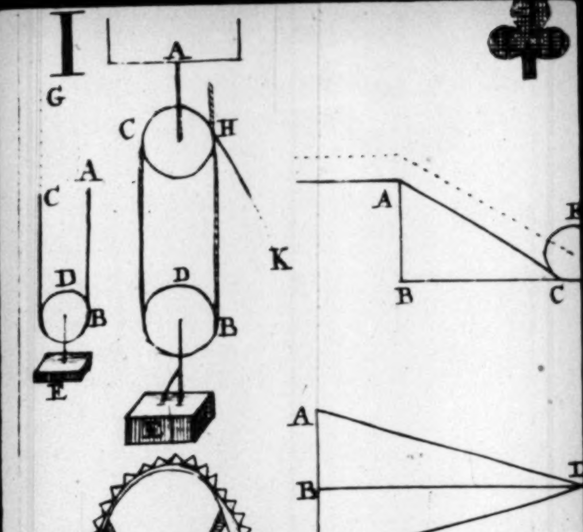
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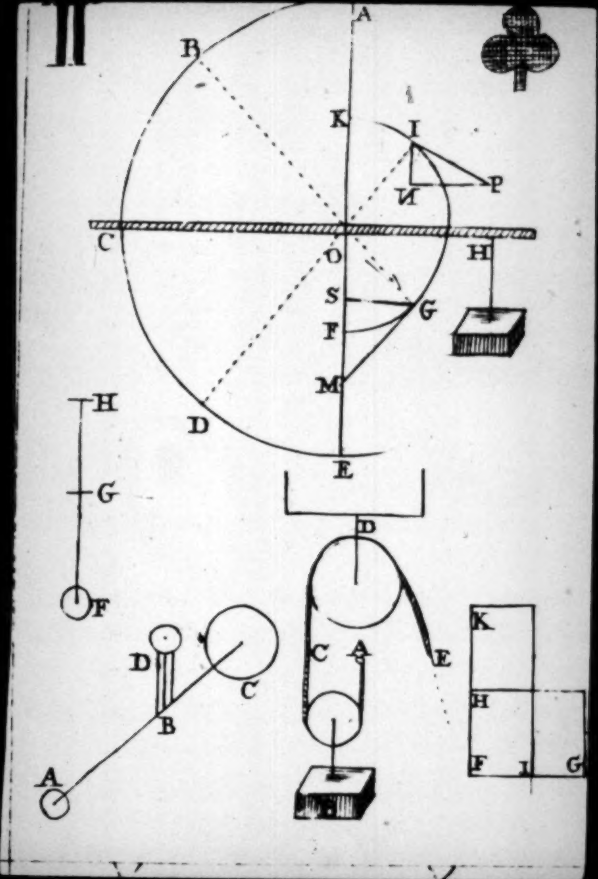
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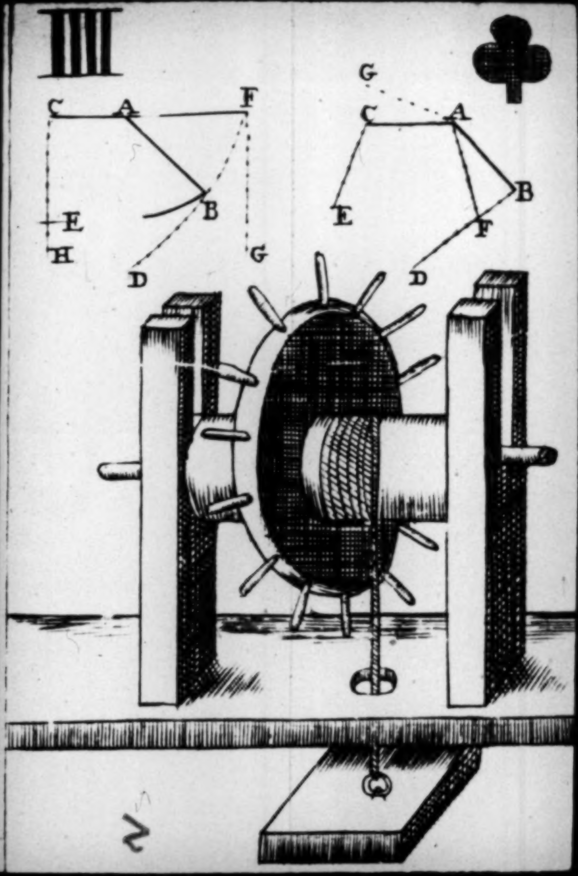
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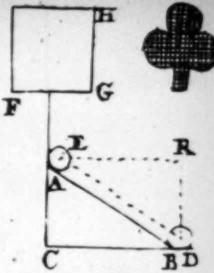
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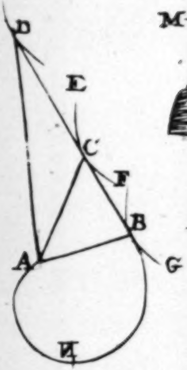
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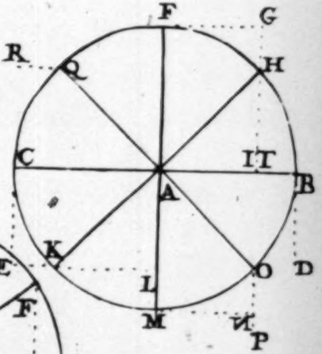
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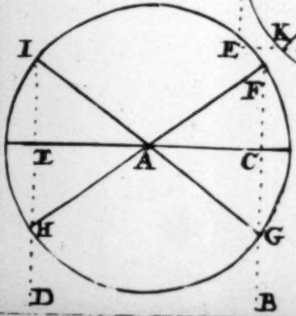
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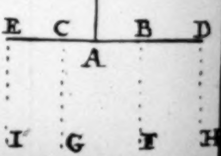
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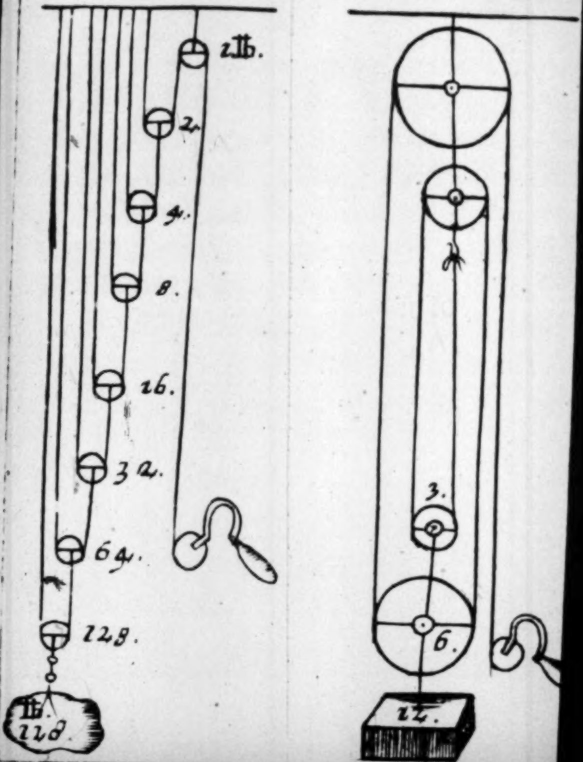

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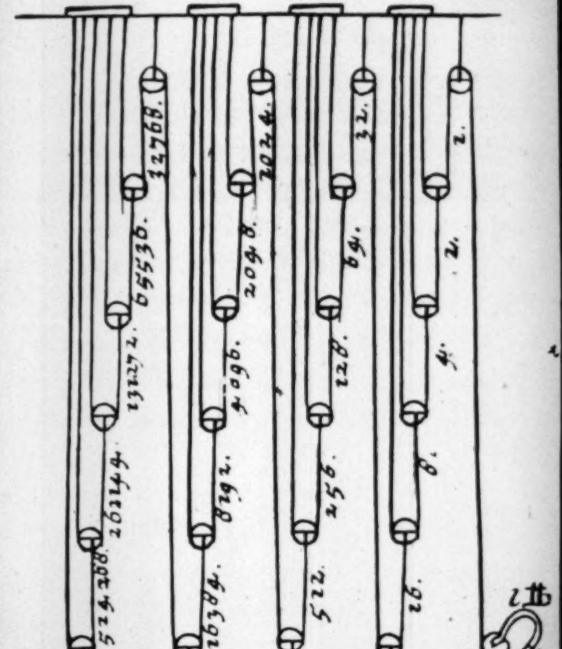

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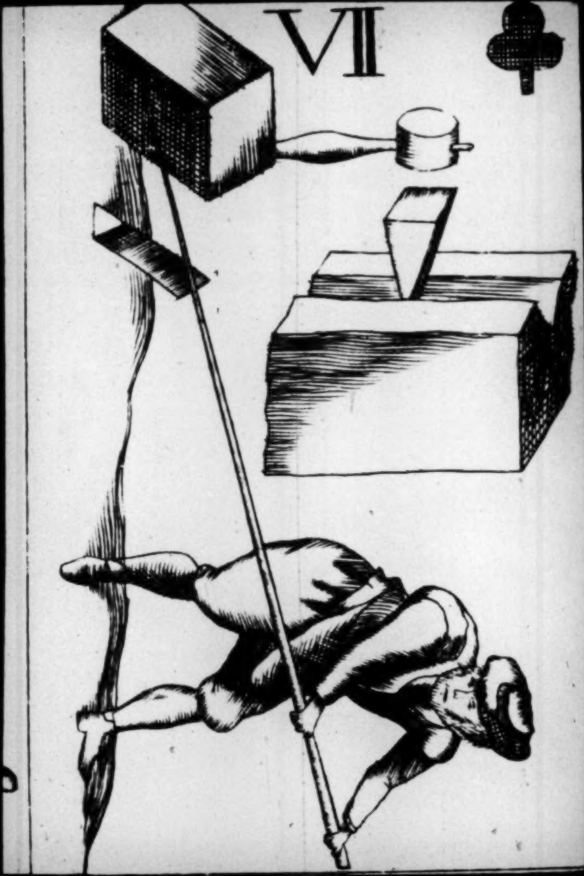
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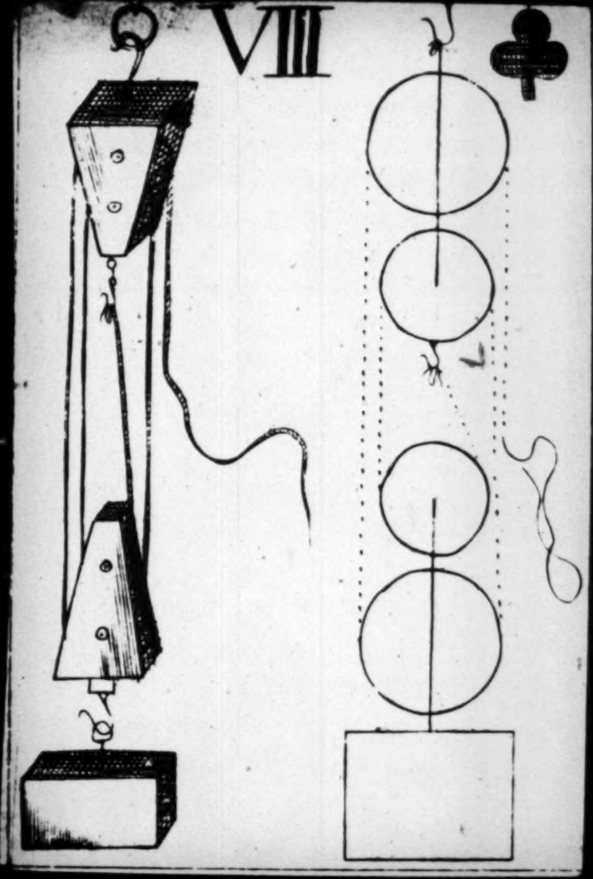
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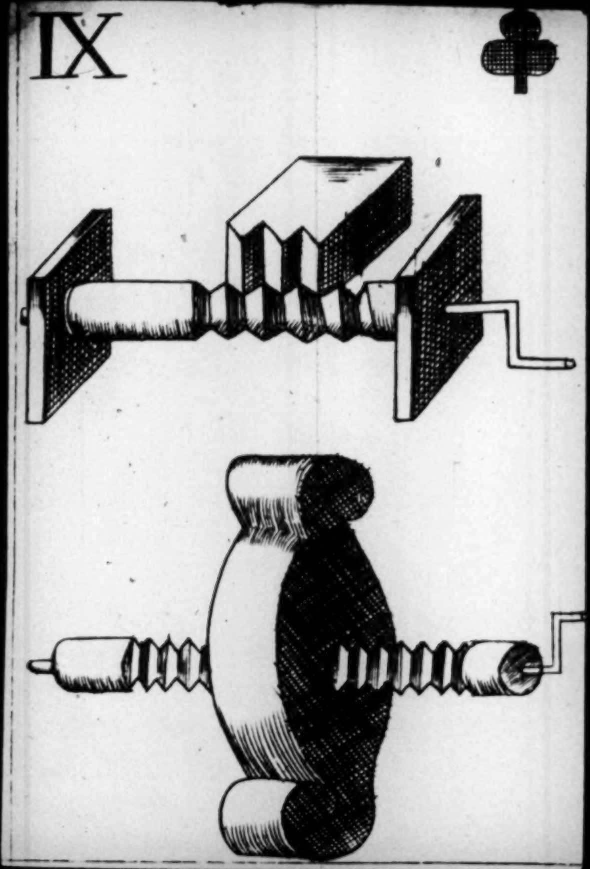
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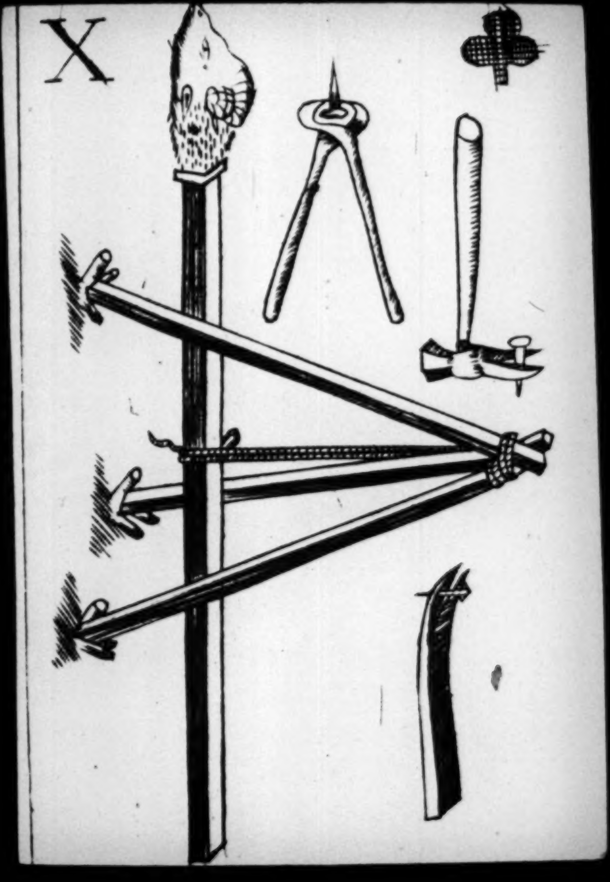
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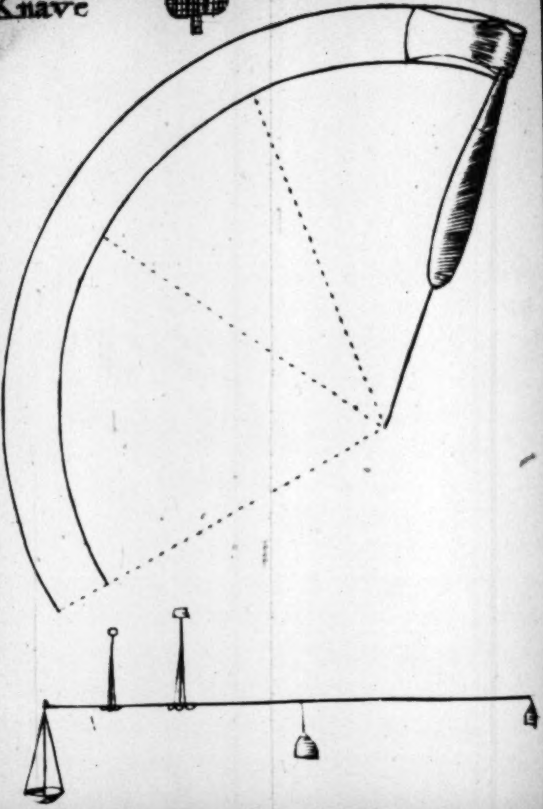

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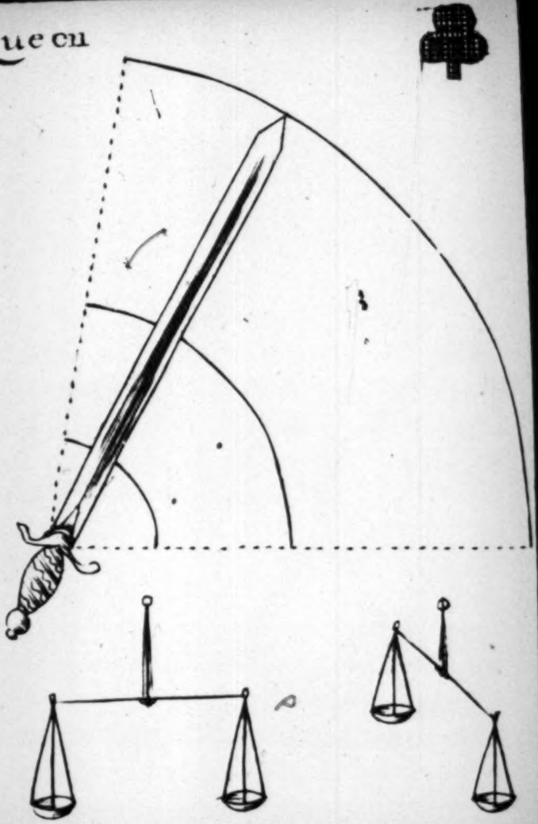

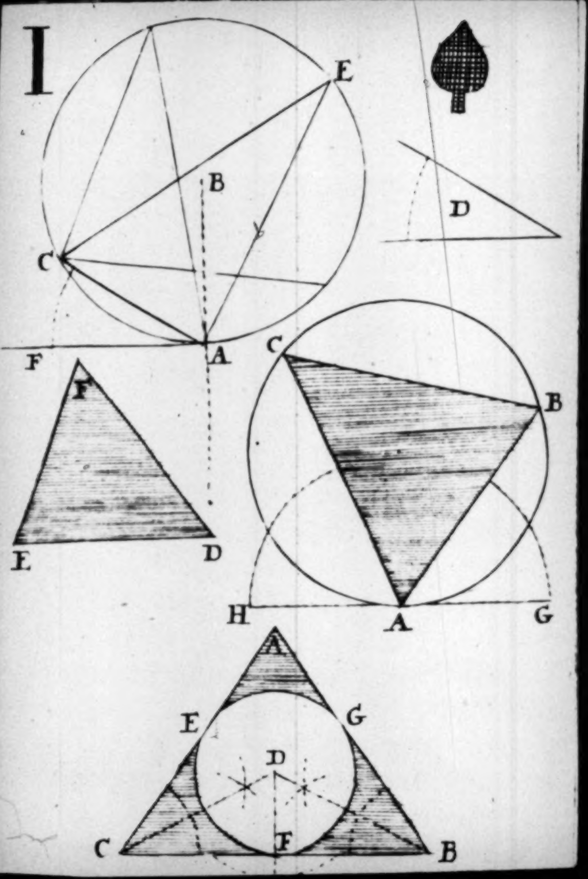
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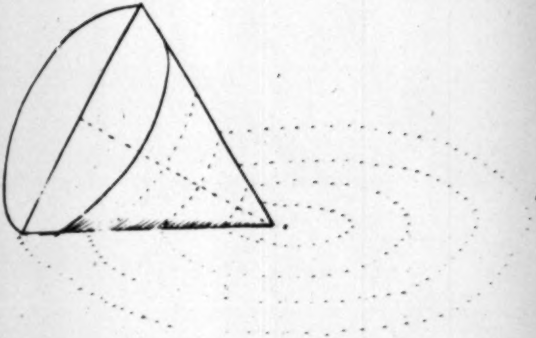

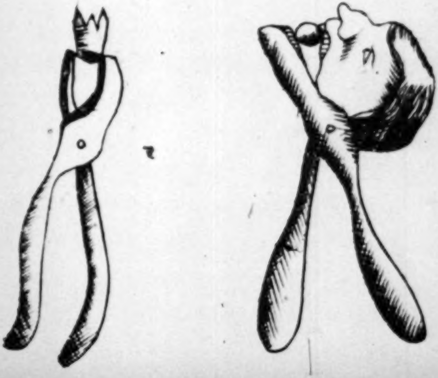

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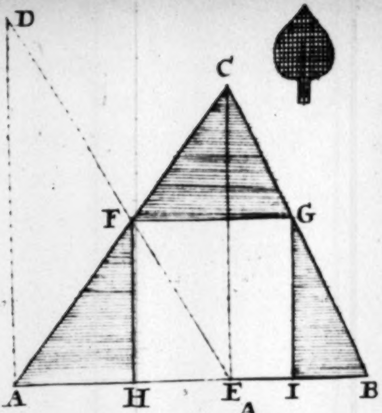

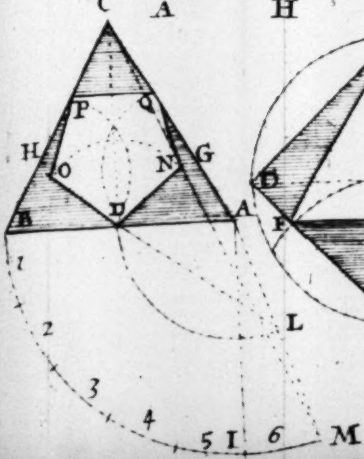

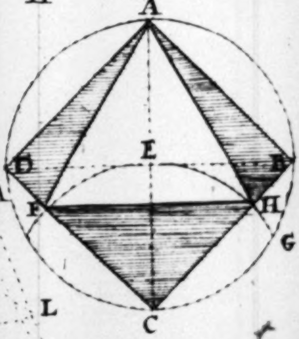

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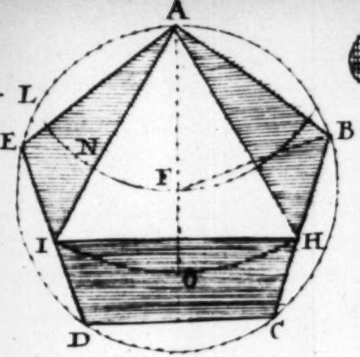

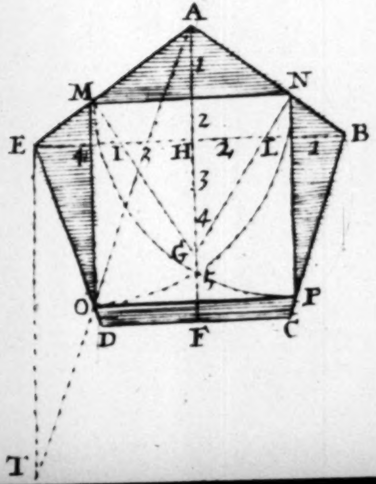

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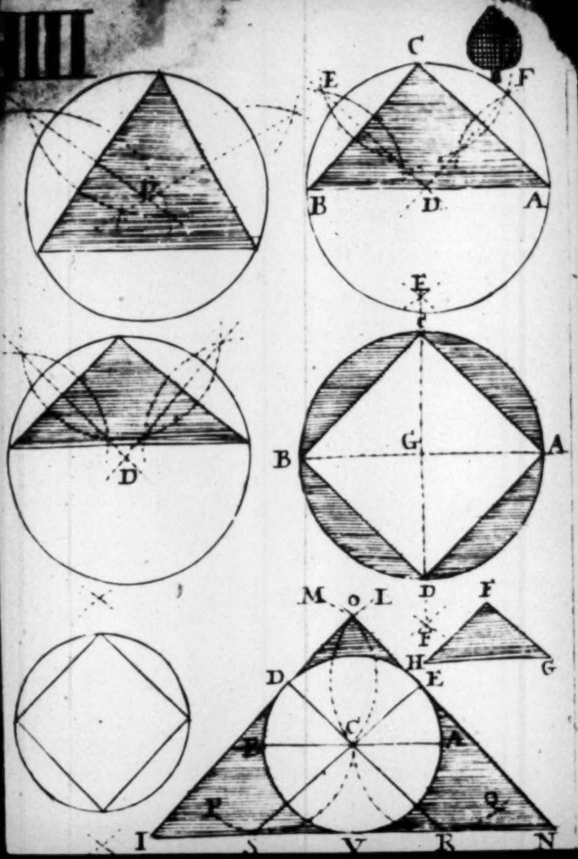

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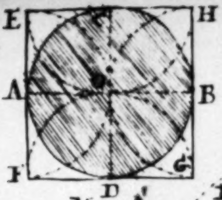

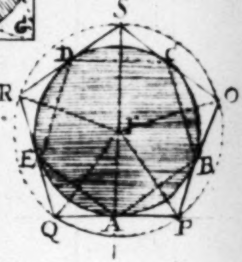

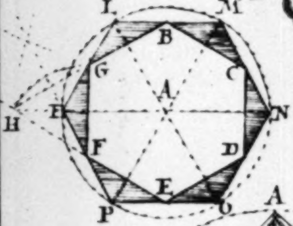

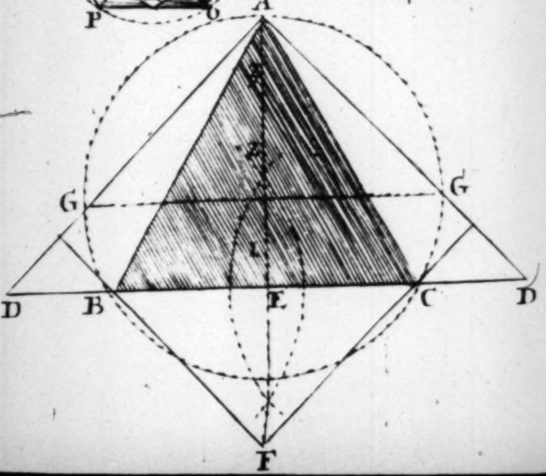

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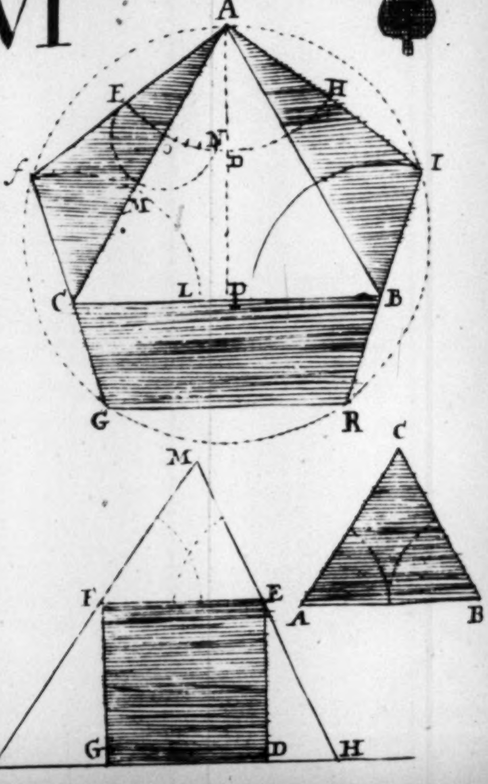

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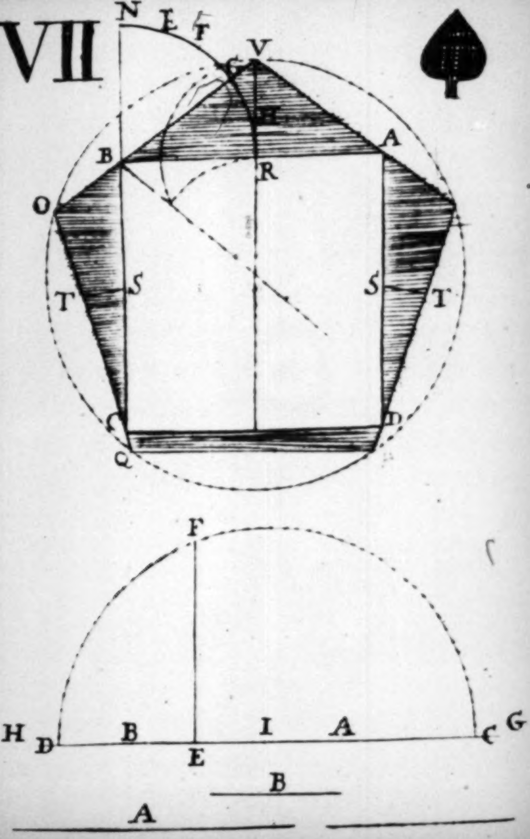

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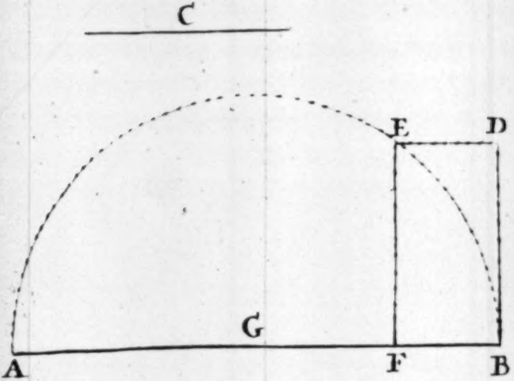

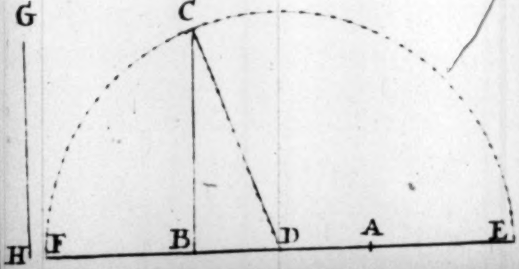

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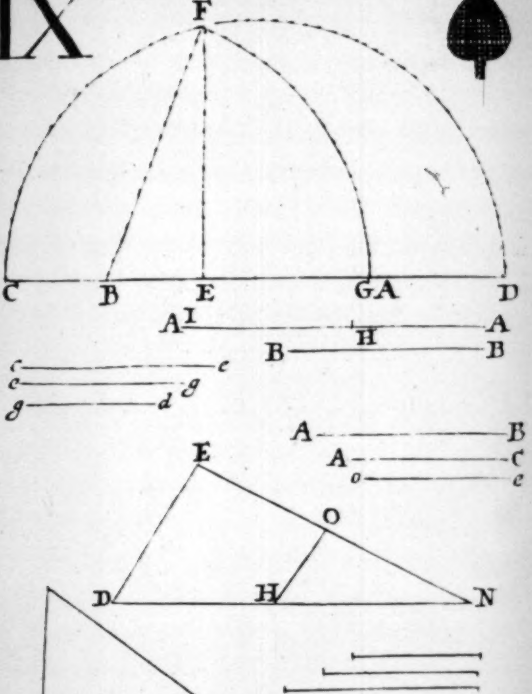

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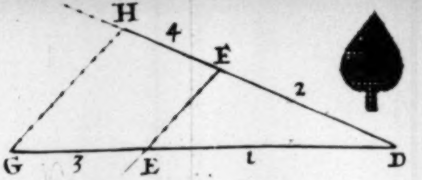

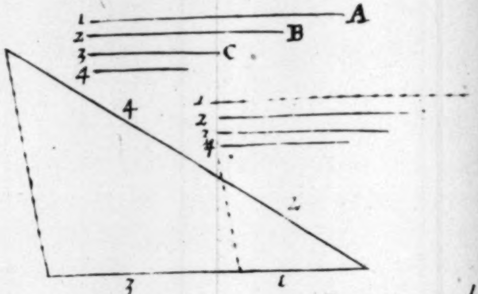

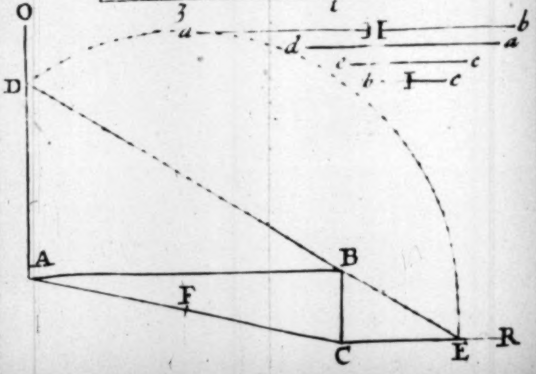

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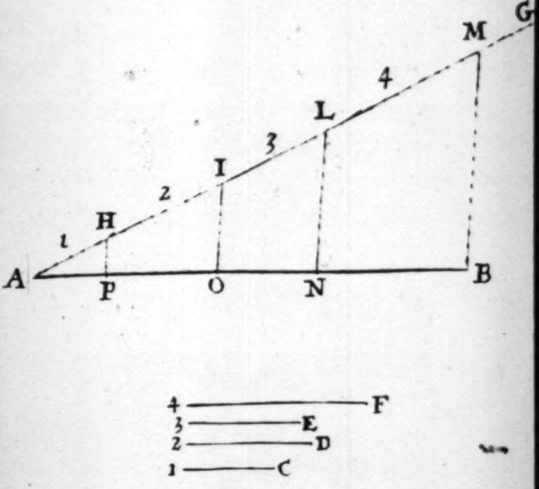

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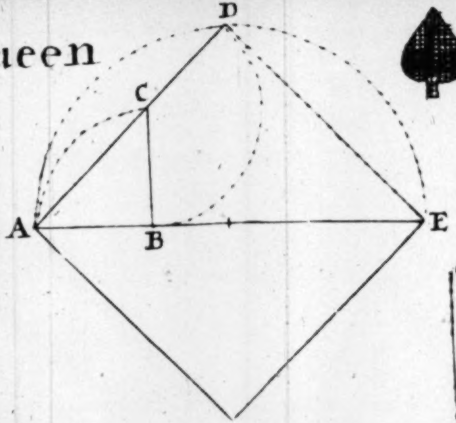

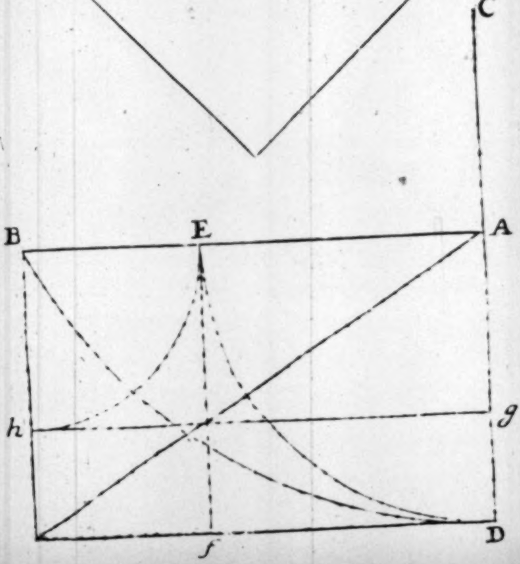

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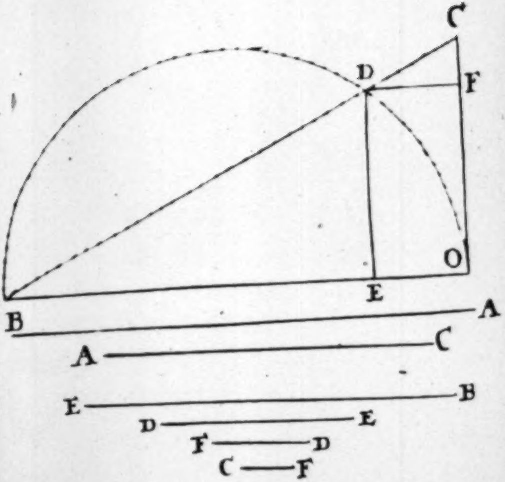

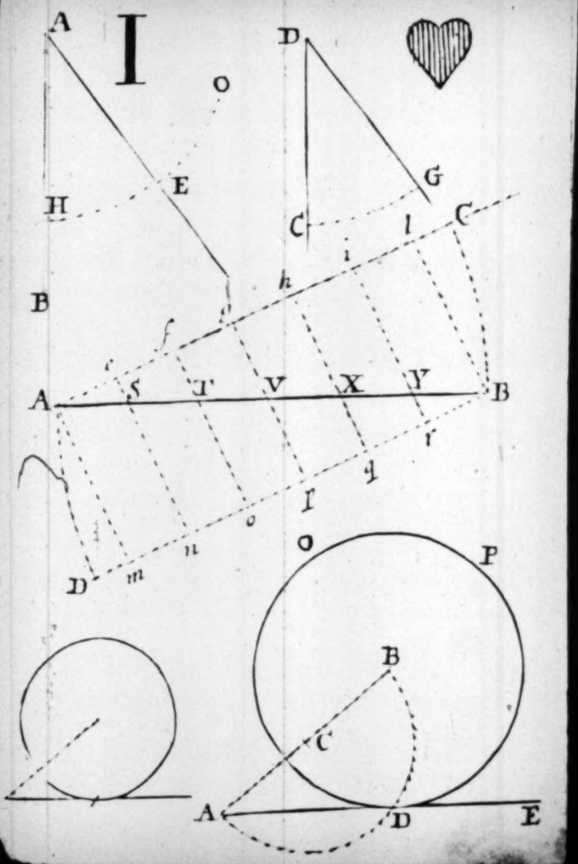
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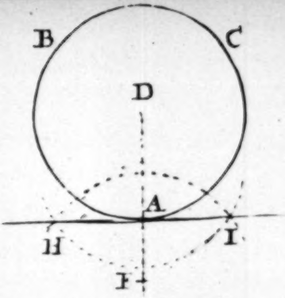

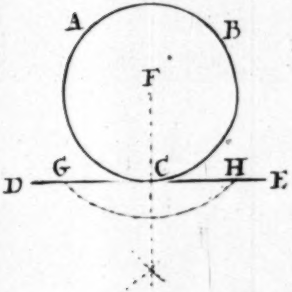

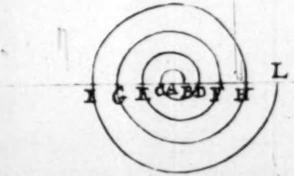

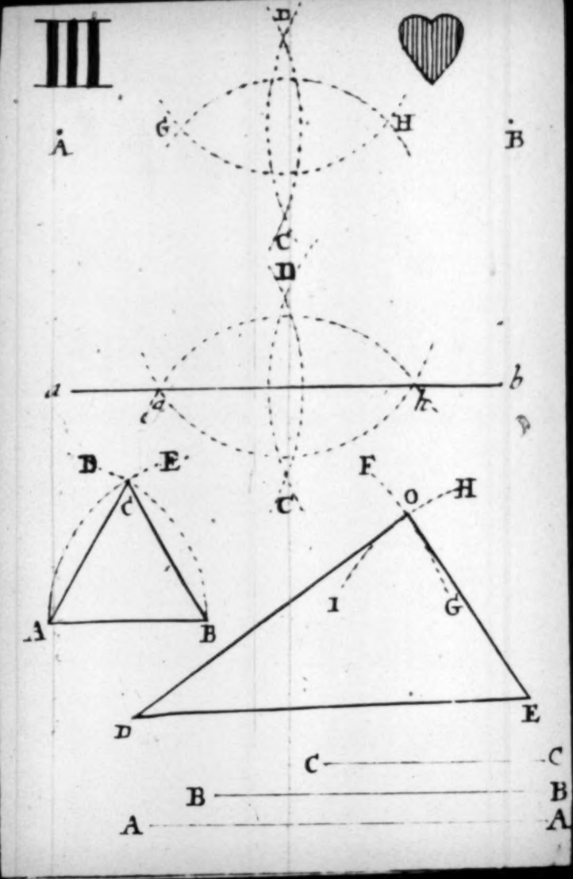
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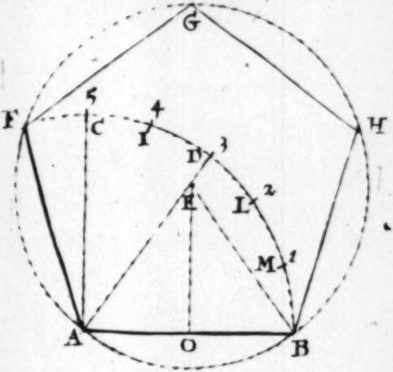

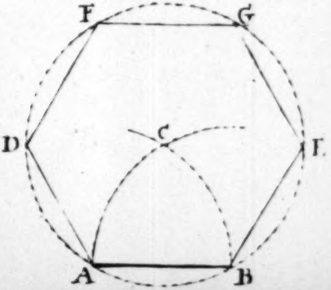

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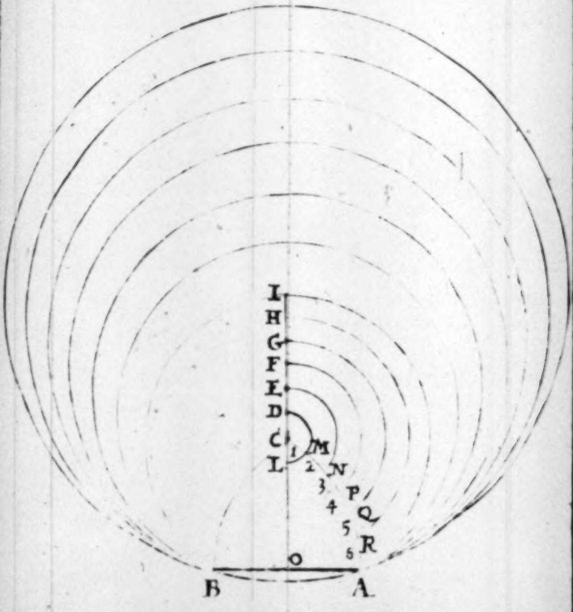

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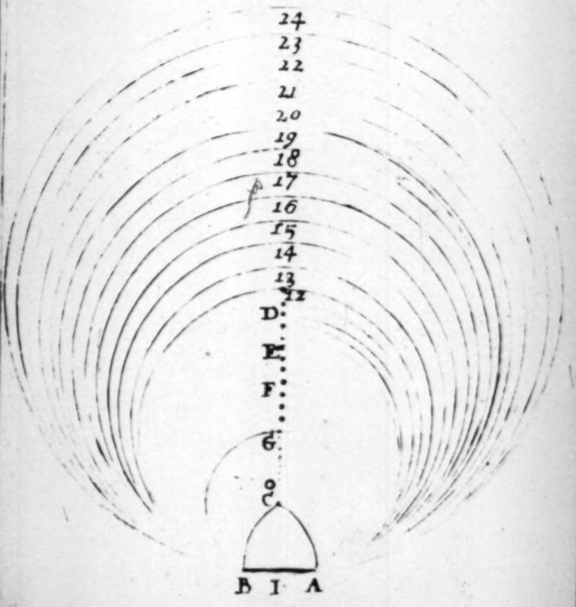

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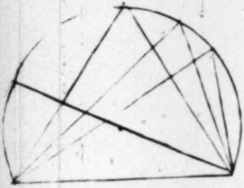

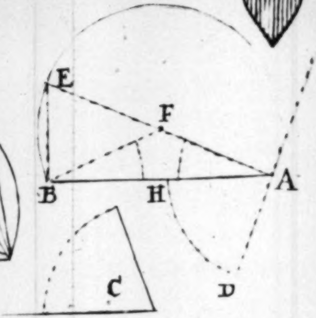

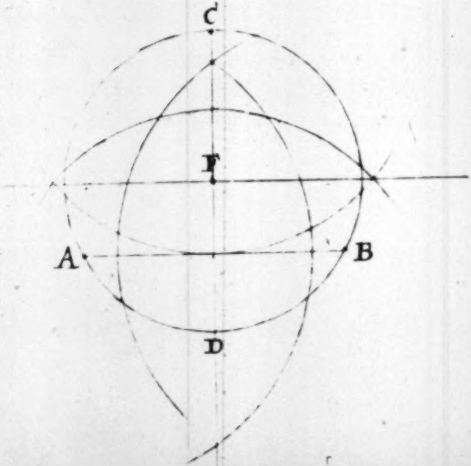

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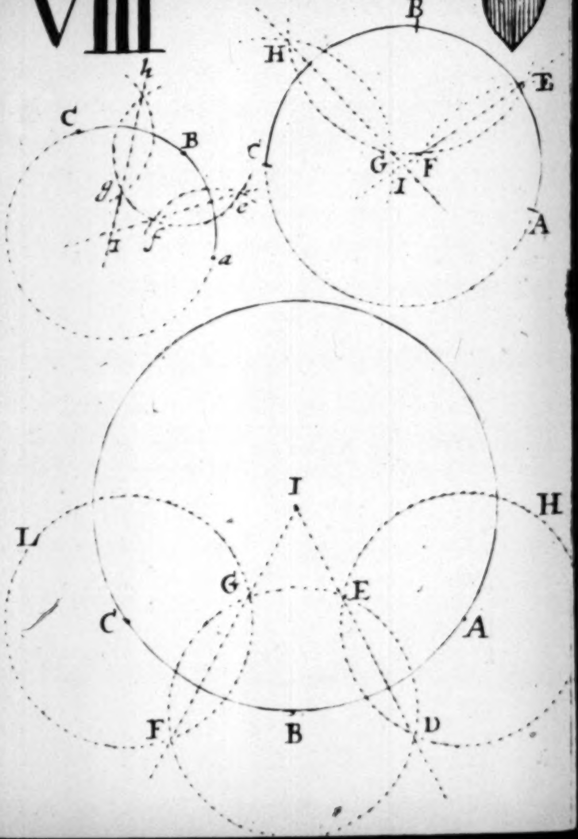

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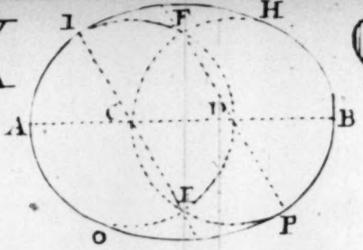

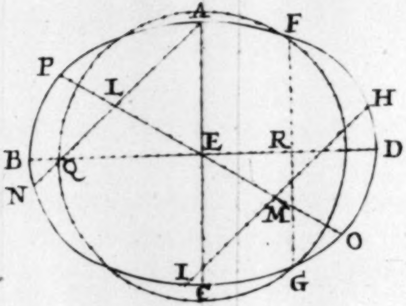

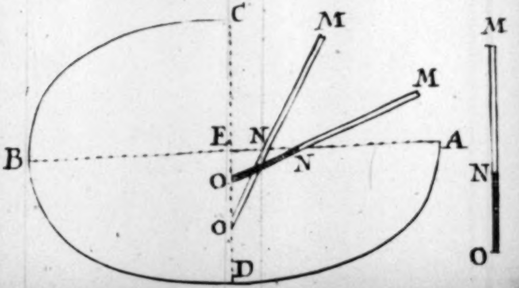

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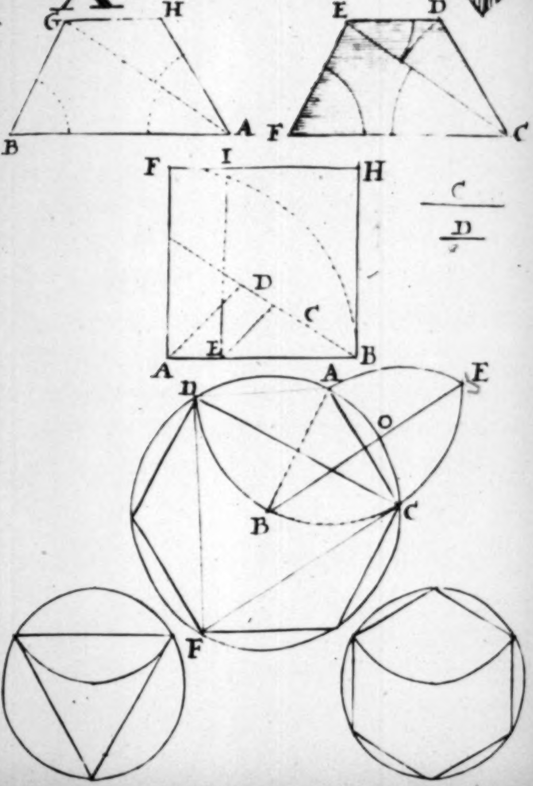

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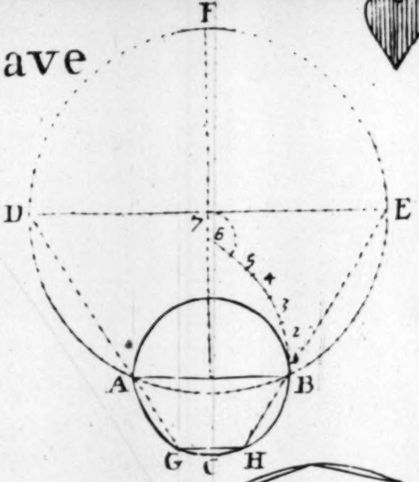

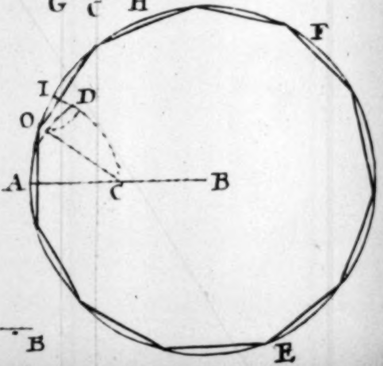

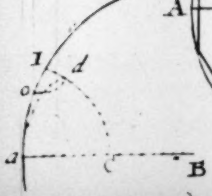

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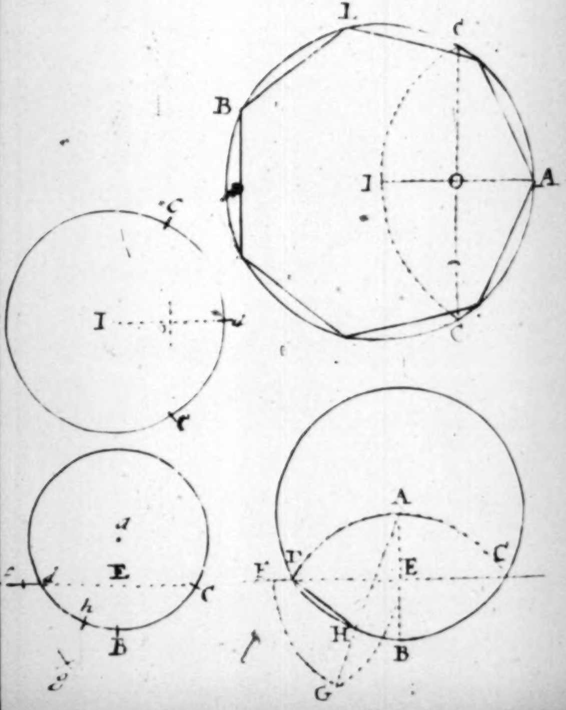

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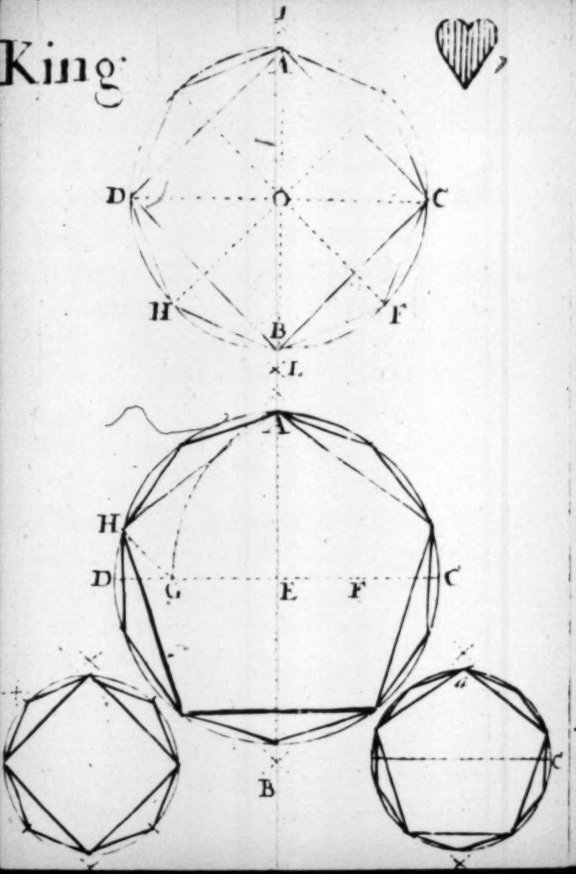

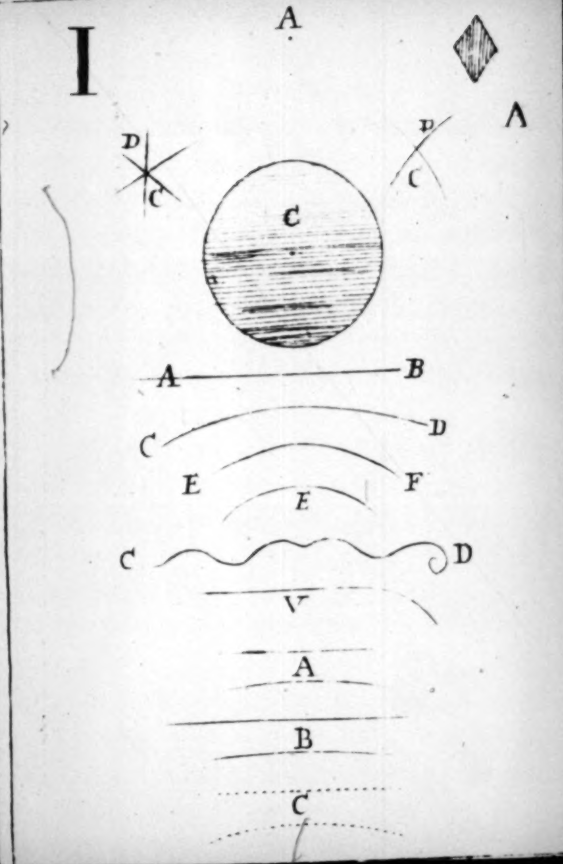
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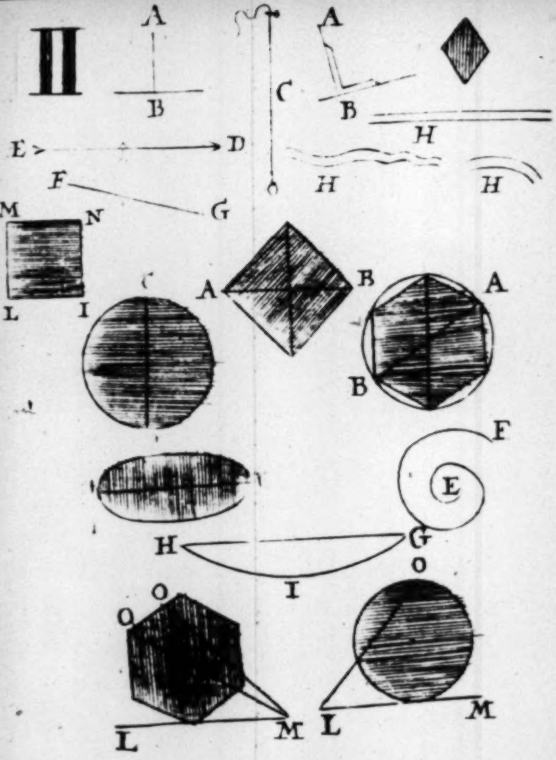

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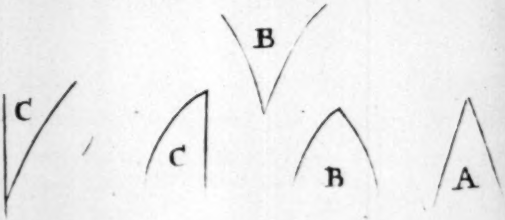

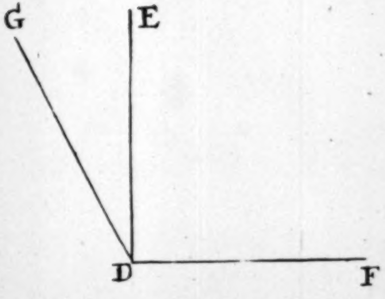

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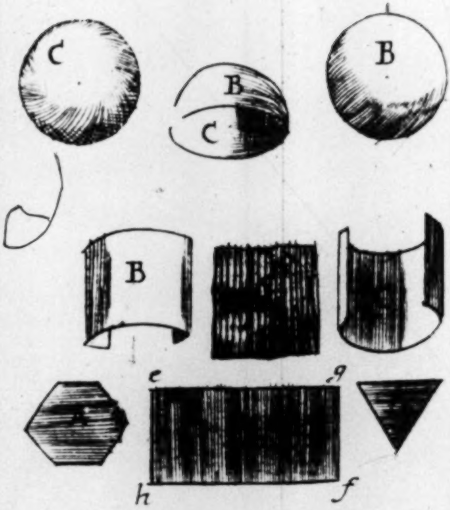

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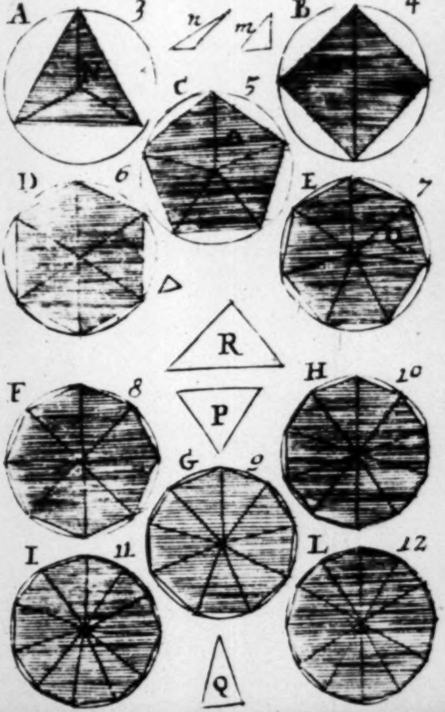

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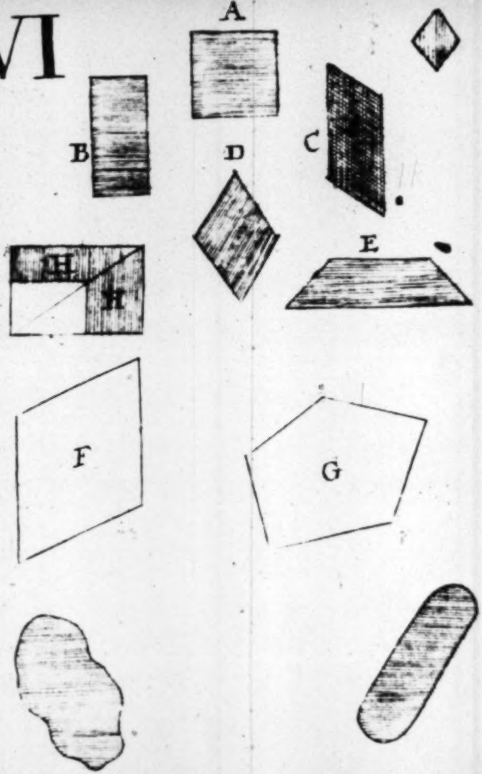

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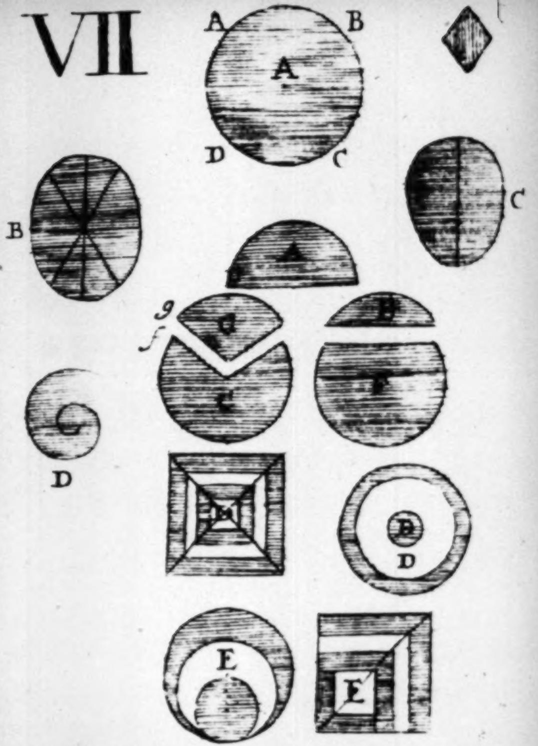

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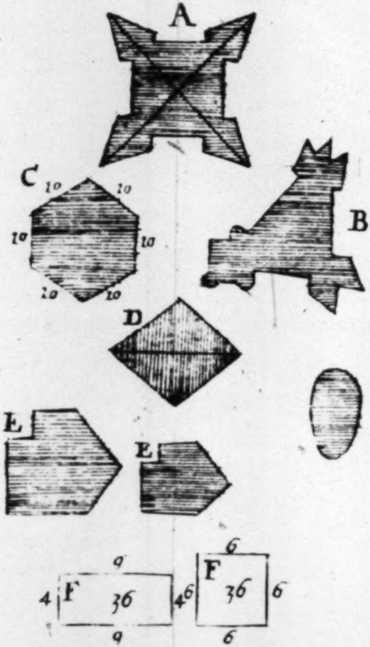

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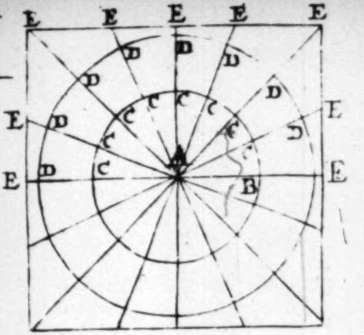
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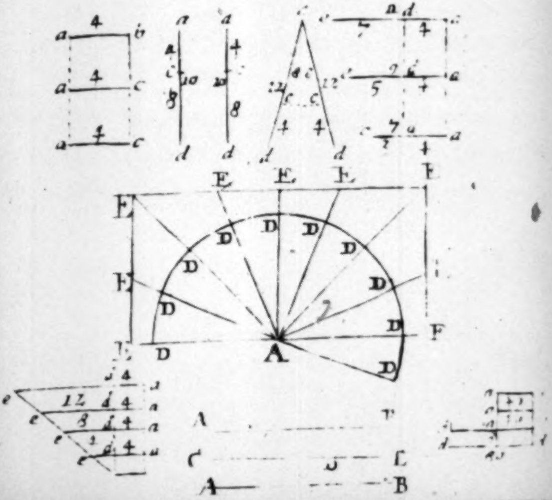
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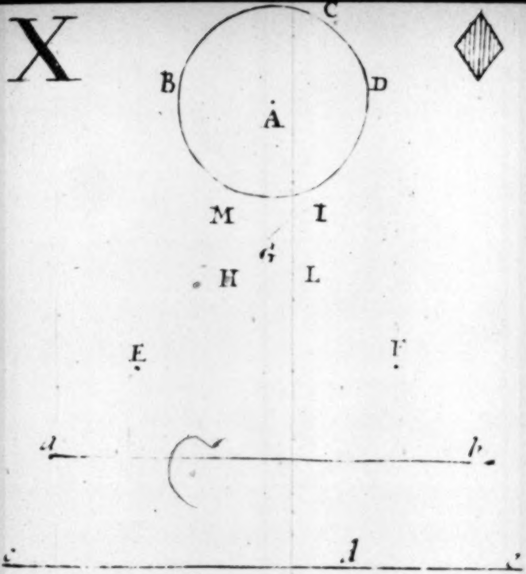
A B

X



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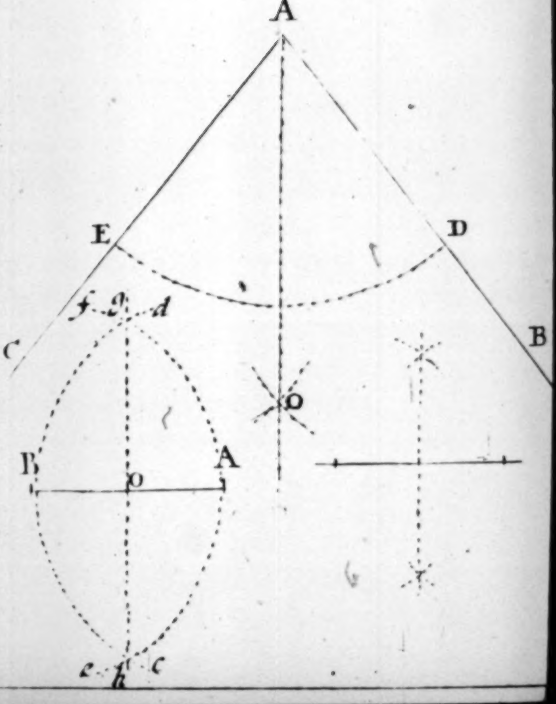

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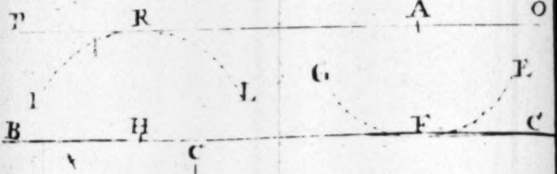

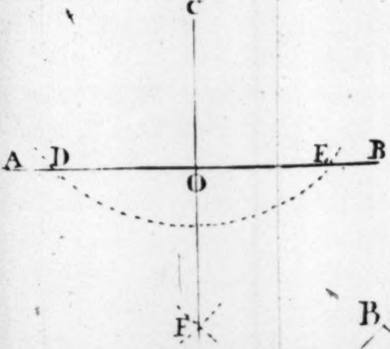

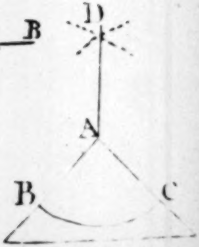

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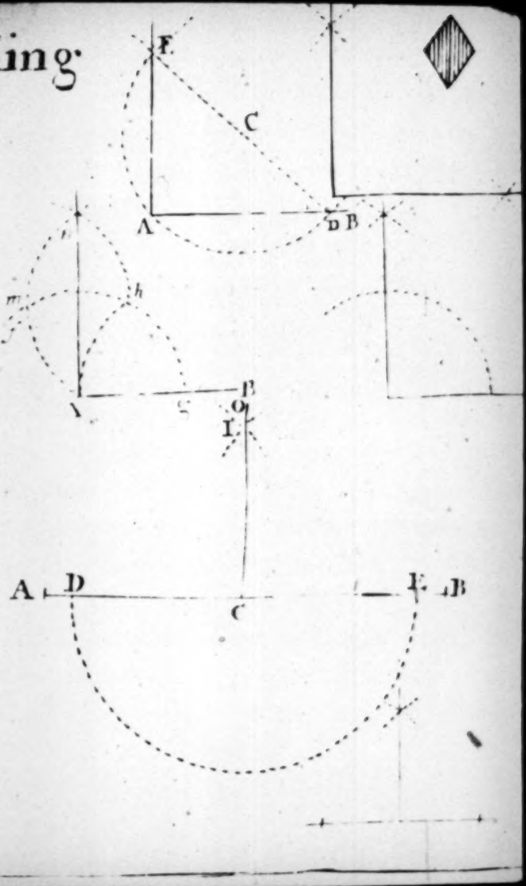

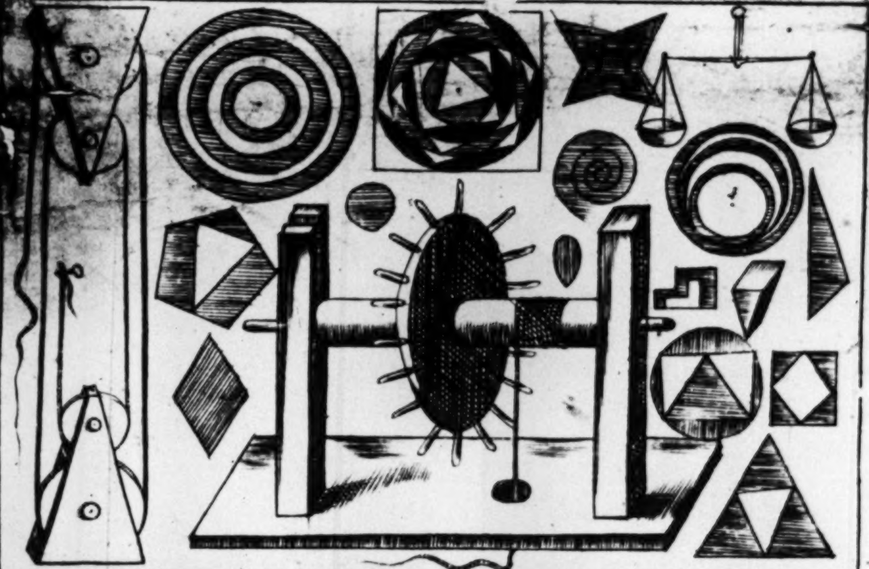

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